The Impact of School Nurse Asthma Education Programme on School Nurses' Asthma Knowledge and Self-efficacy Levels: A Quasi-experimental study

A thesis presented to School of Nursing and Midwifery, Trinity College Dublin,

for the Degree of Doctor in Philosophy.

Zainab Al Kindi

2023

Declaration

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Date: 31st March 2023

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Dissemination of research

The following research outputs published, submitted for publication and/or presented as oral and/or poster presentations form the beginnings of a continuous dissemination plan.

Published papers relating to thesis.

Scoping reviews that were conducted at the beginning of the study to explore the existing knowledge regarding the study area.

1) The review titled "Impact of School Nurse-Led Asthma Education Programme on Child Health Outcomes" was published at Journal of Paediatric Nursing in 2021
   https://pubmed.ncbi.nlm.nih.gov/33759614/

2) The review titled "School Nurse Available Education to Manage School Children with Asthma" was published at Journal of School Nursing in 2021
   https://pubmed.ncbi.nlm.nih.gov/33610087/

Planned research dissemination.

- Draft paper in progress based on findings from this PhD "The Impact of School Nurse-Led Asthma Education Programme of School Nurses' Knowledge and Self-efficacy". Plan to submit for journal publication end of June 2023.

- Plan to meet with the Directorate of School Nursing and the focal point of school nurses in Muscat Governate that supported this study and disseminate findings from August 2023 onwards.

Summary

Background

The prevalence of asthma among schoolchildren in Oman is high. To effectively manage asthma in schools, school nurses require a thorough understanding of asthma, its triggers, and appropriate management strategies. They also need to be confident and capable of responding to asthma emergencies and communicating effectively with parents, teachers, and other healthcare providers. One way to enhance school nurses' knowledge and skills in asthma management is through educational programmes that can help school nurses develop a deeper understanding of asthma management, build their confidence and self-efficacy in dealing with asthma-related issues. Therefore, the purpose of this study was to investigate the impact of an education intervention programme called "School Nurse Asthma Education Programme" on school nurses' asthma knowledge and self-efficacy level.

Study Design

The study employed a a pretest-posttest quasi-experimental design, with an educational intervention programme that was conducted in-person with participants who were school nurses from government-run schools in Oman. The research collected data at four different time points: prior to the intervention, immediately after its completion, three months post-intervention, and six months post-intervention. The outcomes were evaluated using measures of asthma knowledge and self-efficacy levels.

Findings

The first phase of this research revealed that school nurses in Oman have a multifaceted role, similar to their counterparts in other parts of the world. The primary focus of the school nurses in this study is to offer first aid to students in need, which is the most common nursing task in school setting. Providing health education is a paramount aspect of promoting health and well-being of students. This is particularly important in governmental school settings of this study, where full-time school nurses may not be available, making health education even more critical. In addition to their health education role, school nurses also have a delegation role, where they must assess and evaluate the needs of students and delegate tasks to unlicensed personnel to ensure that all students receive the necessary care. However, the effectiveness of delegation

depends heavily on the knowledge and skills of the unlicensed staff. Therefore, the health education role of school nurses is critical in ensuring that the unlicensed staff have the necessary knowledge and skills to perform delegated tasks safely and effectively.

The study findings revealed a significant improvement in the school nurses' asthma knowledge and self-efficacy levels after participating in the programme. Furthermore, the programme was successful in maintaining school nurses' knowledge and self-efficacy up to six months post-intervention, but ongoing education and skill assessment is necessary for the retention of knowledge and skills.

Results also indicated that school nurses had low knowledge related to asthma medication and delivery devices, with particular difficulty recalling indications for asthma medication and inhaler technique. While the intervention improved scores in these areas, these questions remained among the least correctly answered throughout the study. The study further suggested that school nurses require interactive teaching strategies that can promote the retention of knowledge and enhance school nurses’ preparedness to respond to asthma exacerbation.

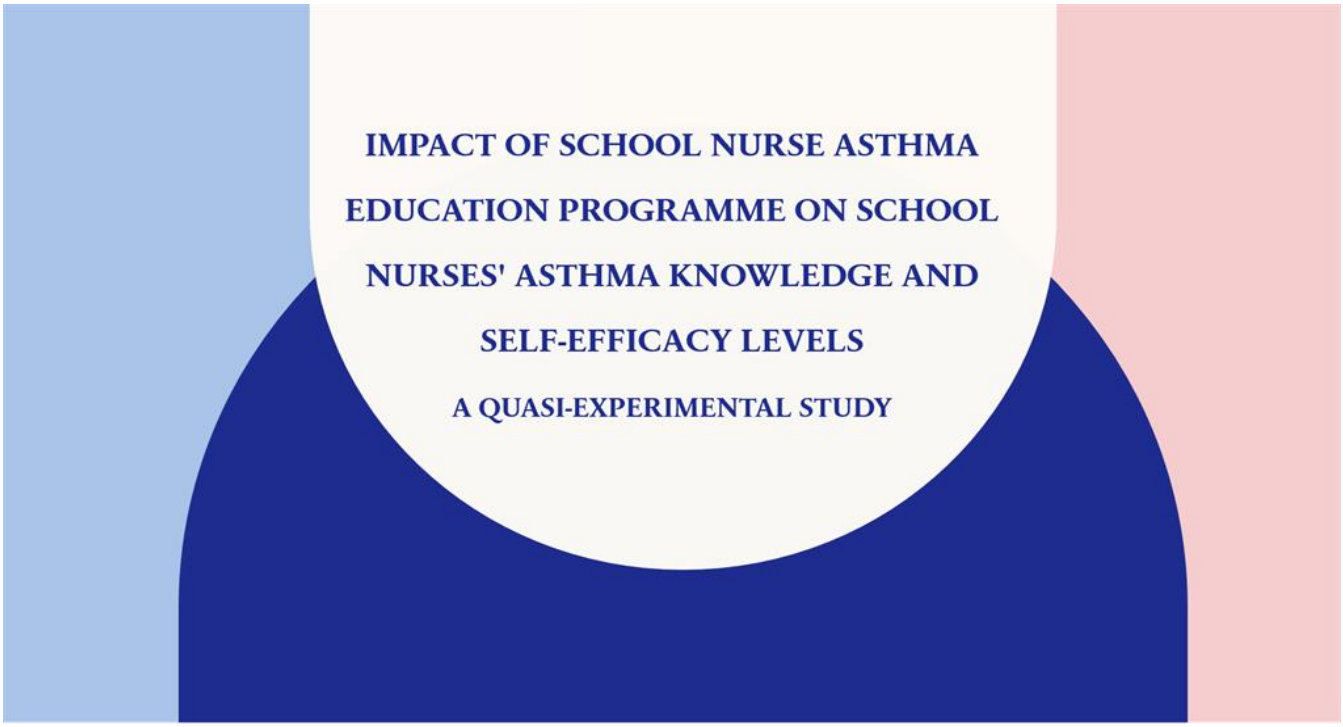
School nurses exhibited greater self-efficacy in areas related to communication with healthcare providers across all four data collection points. On the other hand, school nurses demonstrated lower self-efficacy in managing asthma exacerbations at school without sending the student to the hospital, highlighting the need for clear guidelines outlining the scope of practice for school nurses.

The study indicated that school nurses reported lower self-efficacy in using medication and delivery devices and also had reduced knowledge scores in questions related to medication and delivery devices. There was a strong positive correlation between school nurses' asthma knowledge and self-efficacy before the intervention and moderate positive correlation post intervention supporting the well-known association between the two outcomes.

Despite the small sample size, this study provides a valuable baseline dataset for school nursing in Oman, as it is the first investigation of its kind to be conducted in the country. Additionally, the study contributes to the evidence base surrounding asthma management in school-aged children. It adds to the coherent body of knowledge on how to educate school nurses around

asthma management. The findings suggest that education interventions can be effective in enhancing school nurses' knowledge and self-efficacy.

The Study Infographics



RESEARCH QUESTION

What is the Impact of School Nurse Asthma Education Programme on School Nurses' Asthma Knowledge and Self-efficacy Levels?

INTRODUCTION

The prevalence of Asthma among schoolchildren in Oman is high. To effectively manage asthma in schools, school nurses require through understanding of asthma, its triggers and appropriate management strategies. They also need to be confident in managing asthma emergencies and communicating effectively with caregivers, teaches and other health care providers. One way to enhance school nurses' knowledge and skills in asthma management, is through educational programmes that can help school nurses to develop a deeper understanding of asthma management, early recognition of symptoms and how to respond to asthma-related emergencies.

STUDY OBJECTIVES

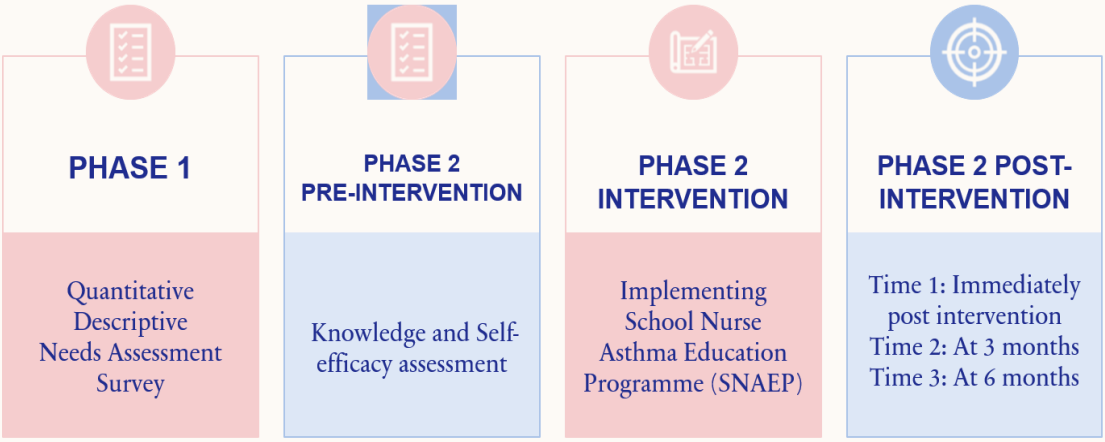
1- Assess role, functions, responsibilities, and educational needs in relation to asthma management in Muscat Governate, Oman.

2- Examine school nurses' asthma management knowledge and s level before and after the intervention

3- Implement SNAEP using GINA guidelines

4- Evaluate the effectiveness of the educational session on schoo knowledge and self-efficacy level in Muscat Governate, Oman.

STUDY PHASES



RESULTS

PHASE 1

- First aid is the most common nursing task at schools
- There is uncertainty regarding the presence or absence of a formal medication administration policy in schools
- School nurses expressed a desire for further education on current asthma guidelines
- Asthma exacerbation is frequently encountered by school nurses

PHASE 2 KNOWLEDGE

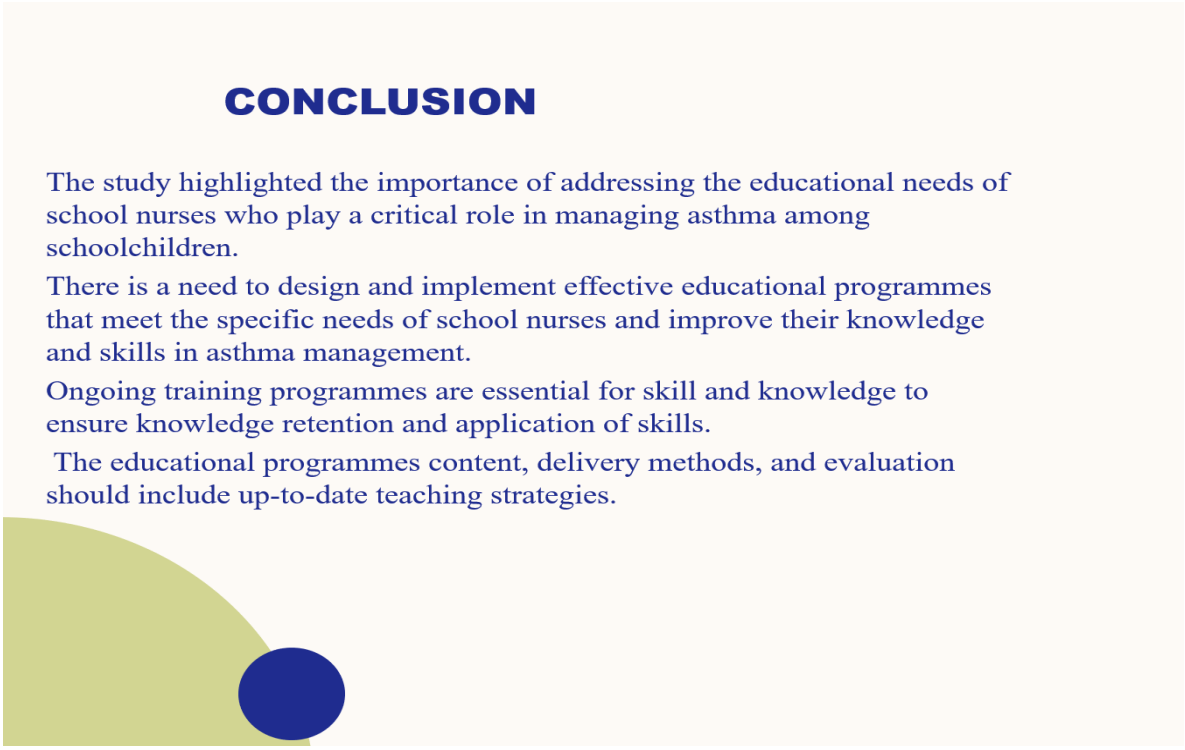
- SNAEP improved school nurses' knowledge up to 6 months postintervention
- Greater knowledge score on items related to asthma as a chronic condition
- Less knowledge score on items related to medication indications and delivery devices techniques

PHASE 2 SELF-EFFICACY

- SNAEP improved school nurses self-efficacy up to 6 months postintervention
- Greater self-efficacy on items related to communication with parents and health care providers

Less self-efficacy on items related to medication indications and delivery devices techniques.

- Positive correlation between knowledge and self-efficacy



List of Abbreviations

Abbreviation	**Meaning**
SNAEP	School Nurse Asthma Education Programme
PFM	Peak Flow Meter
MDI	Metered Dose Inhaler
PHCP	Primary Health Care Provider
ER	Emergency Room
CDC	Centres for Disease Control and Prevention
QoL	Quality of Life
PIL	Participant Information Leaflet
DOT	Directly Observed Therapy

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Glossary

The following definitions of terms can be used to assist with understanding some of the key terms related to the area under study.

Asthma: a chronic inflammatory disorder of the airways in the lungs. The condition is characterized by episodes of breathlessness, wheezing, chest tightness, and coughing, which are caused by airflow obstruction that is often reversible with treatment (Global Initiative of Asthma (GINA), 2022).

Prevalence: The total number of cases of a disease present in a population at

a single point in time.

Asthma Action Plan: a written document that provides personalized instructions for managing asthma symptoms and exacerbations. The plan is developed in collaboration between the patient and their healthcare provider and includes specific instructions for adjusting medications, recognizing early signs of worsening asthma, and seeking emergency medical care if necessary (GINA, 2022).

Peak flow meter: a handheld device that measures the maximum airflow that a person can exhale forcefully in one breath, also known as peak expiratory flow rate (PEFR). The device is used to monitor and manage asthma symptoms and to help identify changes in lung function that may indicate worsening of asthma (GINA, 2022).

Inhaler: a medical device used to deliver medication directly into the lungs in the form of an aerosol mist. Examples of inhalers are metered-dose inhaler and dry powder inhaler (American Academy of Allergy Asthma and Immunology, 2023)

Exacerbation: a progressive deterioration of asthma symptoms, such as difficulty breathing, wheezing, coughing, and tightness in the chest, along with a gradual reduction in lung function, as measured by the peak expiratory flow rate and Forced Expiratory Volume, when compared to the baseline (Sourav et al., 2022). Exacerbation necessitates immediate medical attention, hospitalisation, or treatment involving systemic corticosteroids (Meltzer et al., 2012).

School nurse: a specialist community public health nurses (SCPHN), collaborate with school-aged children, adolescents, and their families to enhance health and well-being results while also minimizing inequalities and vulnerabilities (National Health Service, n.d).

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Chapter 1: Introduction

1.1 Chapter overview

In the introductory chapter, the study's aim and objectives are presented along with a background and rationale for the study. This is followed by an overview of the nine chapters that make up this thesis.

1.2 Background and Significance of the Study

My personal interest in the research topic stems from my role as educator in undergraduate nursing. I have a particular interest in school health and the management of chronic conditions. As a community health nurse lecturer who has worked in schools, homes and primary health care settings, I found that the role of school nurses in chronic disease management is often overlooked.

Asthma is a chronic respiratory condition that affects millions of people worldwide, including school-aged children. School nurses are the first point of contact for students with asthma and play a crucial role in the management of asthma in schools. The prevalence of asthma in schoolchildren has increased in recent years, highlighting the need for effective asthma management strategies in schools. One such strategy is asthma education programmes that are designed to educate patients and healthcare providers about asthma, its management, and prevention. These programmes aim to promote knowledge and skills necessary to manage asthma symptoms, including proper use of medications, avoiding asthma triggers, and recognising the signs of an asthma exacerbation. The evolution of asthma education programmes reflects a growing understanding of the complex nature of asthma and the importance of evidence-based care. These programmes have evolved over time as research has advanced our understanding of the disease and its management. In the early days of asthma education, programmes focused primarily on basic information about the disease, such as its symptoms and how to use inhalers. However, as the medical community learned more about the disease, education programmes became more comprehensive, addressing topics such as asthma triggers, self-management techniques for patients, and the importance of adherence to

medication regimens. As technology has advanced, asthma education programmes have also evolved to include online resources and mobile applications.

Asthma education programmes are typically developed by healthcare professionals, including physicians, nurses, and respiratory therapists, and are delivered in various formats, including individual and group sessions and online resources. Additionally, these programmes often involve teaching about asthma symptoms' monitoring and effective communication with their healthcare team. The literature continues to emphasise the importance of asthma education programme on enhancing health care providers knowledge, skills and resources to effectively manage asthma. Due to the significant impact of asthma on the health and academic performance of students, many schools have implemented educational programmes to help manage the condition. These programmes can be particularly relevant to asthma management by school nurses, as they can provide school nurses with the knowledge and skills needed to identify and manage asthma in the school setting. School nurses play a crucial role in delivering these programmes, as they are often the first point of contact for students with asthma. Effective asthma educational programmes for school nurses should include several key components, such as providing up-to-date information about asthma, its triggers, and its symptoms. Nurses should also be trained on how to identify and manage asthma emergencies, administer medication, and help students develop and follow an asthma action plan.

Despite the importance of school nurse asthma education programmes, there is limited research on their effectiveness in improving the knowledge and self-efficacy levels of school nurses. Therefore, this study is significant as it seeks to fill this knowledge gap by evaluating the impact of a School Nurse Asthma Education Programme (SNAEP) on the knowledge and self-efficacy levels of school nurses. The findings from this study will provide valuable insights into the effectiveness of school nurse asthma education programmes, which can inform the development of future programmes and interventions aimed at improving asthma management in schools. The significance of the study is further emphasized by the fact that limited research has been conducted on the impact of school nurse asthma education programmes in the Middle East region, including Oman. This study, therefore, represents the first of its kind in Oman to explore school nurses' role and asthma educational needs. By examining the impact of SNAEP, the study will provide unique insights into the effectiveness

of such programmes in the local context. The findings from this study have the potential to inform and improve school nursing practices in Oman and other Middle Eastern countries, which can ultimately contribute to improving asthma management and the quality of care for school-aged children with asthma. The study's results can also provide a basis for future research in the region, which can lead to the development of more effective interventions and programmes for managing asthma in schools.

1.3 Aim and Objectives

The aim of the study is to examine the impact of School Nurse Asthma Education Programme (SNAEP) on school nurses' asthma knowledge and self-efficacy levels. Objectives of the study are to:

1- Assess role, functions, responsibilities, and educational needs of school nurses in relation to asthma management in Muscat Governate, Oman.

2- Examine school nurses' asthma management knowledge and self-efficacy level before and after the intervention

3- Implement SNAEP using GINA guidelines

4- Evaluate the effectiveness of the educational session on school nurses' asthma knowledge and self-efficacy level in Muscat Governate, Oman.

1.4 Thesis Structure

This thesis is presented across nine chapters. This chapter is presented as the introductory chapter, inclusive of the study aim, objectives, and rationale. Chapter 2 provides an outline of asthma as a chronic disease, its prevalence worldwide and in the context of Oman in particular. It highlights the global burden of asthma and factors associated with increased asthma prevalence among children. It also presents the current asthma guidelines with a priority given to prevention of asthma exacerbation. This chapter provides an overview of nursing workforce in Oman, focusing on school nursing and its central role in asthma management. Additionally, this chapter highlights the lack of research exploring the profile and role of school nurses in asthma management in Oman.

Chapter 3 presents a scoping review that explores school nurse-led asthma intervention programmes and their impact on children's asthma-related health outcomes. A total of 7

studies (946 school-aged children and 15 school nurses) were included. The review found that school nurse-led asthma programmes which were predominantly educational interventions had a positive impact on children's asthma health outcomes including reduced health cost, improved medication adherence, and decreased asthma symptoms. Asthma exacerbation was not assessed as a health outcome for school-nurse led asthma intervention programmes. The review placed significant emphasis on the importance of school nurse leadership in driving the development and implementation of school-based asthma programmes. The review also emphasised that a school nurse-led asthma programme should be continuous as it is important to highlight the chronic nature of asthma. Short-term once-off interventions are not sufficient to effectively manage asthma in schools.

Chapter 4 presents a scoping review of worldwide evidence of the education and training school nurses require to manage asthma in school settings. A total of 8 studies (2,468 school nurses) were included. The review highlighted that knowledge and skill deficiency among school nurses and the health care team is a consistently reported challenge to asthma management at school setting and recommended ongoing continuing asthma educational sessions for school nurses. The studies included in this review have also underscored the inconsistency in the use of multiple knowledge instruments and the lack of tool development and validity of school-nurse specific needs assessment surveys. Additionally, the review recommended conducting asthma education programmes for school nurses following educational needs assessment. The review pinpoint for the need for future longitudinal studies to examine the resulting changes over time and to evaluate the sustainability of changes in the practice of school nursing following asthma educational programmes. Importantly, the review spotlighted that there is no coherent body of knowledge regarding the method and structure of asthma education programmes for school nurses. The scoping review of the literature in Chapters 3 and 4 identified a clear gap in the evidence that warrants further investigation and sheds light on a number of issues that had important implications for the design of this study. When investigating educational interventions that aim to change practice, evidence-based practice advocate for the use of "real life research".

Chapter 5 discusses why a research design encompassing a quasi-experimental study with four data collection time points was considered the most appropriate for this study with a discussion

on the epistemological, ontological, and philosophical assumptions that shaped and guided the study. The methodology of the study involved a two-phased approach. In phase 1, a descriptive quantitative needs assessment survey was conducted to identify asthma educational needs of school nurses. Data were collected once-off during this phase using needs assessment survey that was developed to explore school nurse's role, function and asthma educational needs. In phase 2, a School Nurse Asthma Educational Programme (SNAEP) was implemented incorporating findings from phase 1. Data were collected at four data collection time points during this phase: before the intervention, immediately after, 3 months post-intervention, and 6 months post-intervention. The multiple data collection time points in phase 2 allowed for the examination of the intervention's short-term and long-term effects. The data were analysed using appropriate statistical methods, such as descriptive statistics and inferential statistics, to examine changes in outcomes over time. Overall, the total number of respondents in phase 1 was 49 and the number of school nurses who attended the educational programme and returned the completed forms was 36. The ethical principles of Respect of Persons, Informed Consent, Beneficence, and justice provided a framework for identifying issues relating to the protection and respect of participants in the study.

Chapter 6 provides a detailed account of how I prepared for the study by managing access to research participants and requesting a gatekeeper. In addition to Trinity College Dublin ethical approval, approval of the study was granted by Ministry of Health (MOH) and Ministry of Education in Oman. Details relating to recruitment of participants and challenges encountered during study approval and intervention implementation are discussed.

Chapter 7 presents the findings on needs assessment survey in phase 1 and the findings of the intervention phase. In total 49 school nurses who serve 110 schools, agreed to participate in needs assessment survey, 70 % response rate. For intervention phase, 40 school nurses attended the education programme and 36 returned the completed surveys. These 36 school nurses were followed up to 6 months post intervention. Asthma knowledge and self-efficacy scores were presented for the four data collection times.

Chapter 8 discusses the findings of the study in the context of the literature. The results of the study are discussed based on the objectives. School nurses 'role, functions and educational needs are presented with a comparison of the existing literature. The impact of School Nurse

Asthma education Programme is discussed in the context of the two outcomes of knowledge and self-efficacy. Chapter 9 discusses the implications of study findings on policy, practice and service delivery, education and training and research recommendations. Limitations of study are included also in this chapter.

Chapter 2: Childhood Asthma and the Role of the School Nurse in Asthma Management

2.1 Introduction

This chapter begins with an introduction to the broad concept of chronic diseases and then narrows its focus to a discussion of childhood asthma, its global prevalence and its occurrence in Oman in particular. It also provides an overview of the nursing workforce in Oman, focusing on school nursing and its central role in asthma management. Additionally, this chapter highlights the lack of research exploring the profile and role of school nurses in asthma management in Oman.

2.2 Chronic Diseases

The incidence, prevalence and mortality rate of infectious diseases have declined around the world due to advancements in vaccination, sanitation and treatment. This has resulted in increased life expectancy and a consequent shift in the disease burden from infectious to non-infectious chronic diseases (Goodman et al., 2013; Naghavi et al., 2017). The World Health Organisation (WHO) definition of chronic conditions states that chronic diseases, usually characterised as long in duration and slow to progress, do not pass from one person to another, and are typically the result of a combination of genetic and lifestyle factors (WHO, 2021). Cardiovascular diseases, chronic respiratory diseases, diabetes and cancer are the four main types of chronic disease (WHO, 2021).

Most chronic diseases have no cure and are characterised by the lack of a clear pattern of symptoms, making it difficult to anticipate the progress of the disease (Kerr & Haas, 2014). For

example, whereas one individual with asthma might suffer from difficulty breathing, another with sickle cell disease may live with chronic pain. However, people with chronic diseases may share similar challenges related to their self-esteem, financial status, social role, employment difficulties and day-to-day lives (Goodman et al., 2013). The literature emphasises the need to conduct interventions that tackle the burden of chronic disease. Since asthma is one of the most common chronic diseases in adults and the most common chronic disease among children in particular (Ellwood et al., 2017; Meghji et al., 2021), addressing the unpredictable symptoms associated with such an ongoing condition is a key aspect of its management (Clayton et al., 2018). Also needed are constant revisions in plans of care and alterations in day-to-day life (Scambler, 2018).

2.3 Childhood Asthma

Although it is unclear whether asthma is a single disease or a group of conditions resulting in the same clinical manifestations (Pavord et al., 2018), the Global Initiative for Asthma (GINA) defines asthma as a chronic incurable respiratory disease characterised by inflamed airways. Wheezing, shortness of breath, chest tightness and cough are common symptoms of asthma (GINA, 2022). A period of airflow obstruction in the affected individual is known as an asthma episode, attack or exacerbation. Asthma exacerbation occurs when symptoms happen suddenly and become much worse, and this can be life-threatening. The causes of asthma are not fully understood; however, environmental and genetic factors (e.g., race, ethnicity, family history) are potential contributing factors (National Heart Lung and Blood Institute, 2022).

Despite the various asthma phenotypes described in children, asthma is recognised as a chronic inflammatory disease of the airways with limited expiratory airflow; it may resolve spontaneously or with the use of medication (Global Asthma Network, 2018). Childhood asthma is known for its overall high prevalence (Section 2.3.1) and is predominant in males in the first decade of life. After puberty, however, asthma appears to be more common among females (Wright et al., 2006; Trivedi & Denton, 2019). Childhood asthma cases commonly go into remission, and mortality is rare (Sections 2.3 and 2.4.3; (Trivedi & Denton, 2019). Children have smaller airways, therefore increasing the seriousness of the condition for them. Small airway passages tend to block easily when inflammation occurs, leading to asthma exacerbation.

Children often exhibit few day-to-day symptoms but can experience severe exacerbation in response to particular triggers, such as cold weather, cigarette smoke or seasonal allergies. Children's lungs are still growing, and early exposure to triggers can alter lung development. There is strong evidence from at least five longitudinal studies that children who are exposed to greater concentrations of complex air pollutants (Section 2.3.2.4) are at risk for not achieving optimal lung development by the time they reach adulthood (Linares et al., 2010; Mölter et al., 2013; Nishimura et al., 2013; Stern et al., 2013; Jedrychowski et al., 2015). The natural history of asthma in children is different than that of asthma in adults, with more reported remission found in children. A longitudinal study of 879 North American children (the mean ± SD baseline age was 8.8 ± 2.1 years) who were followed for 12 years reported that, by adulthood, 340 (38.6%) participants had asthma remission (Wang et al., 2019). In a Swedish study, 205 children with a confirmed asthma diagnosis in early school age (ages 7−8) were also monitored for 12 years. By age 19, 21% reported being in remission (Andersson et al., 2013).

2.3.1 Childhood Asthma Prevalence

Asthma is the most common chronic disease among children, with increased prevalence in the past 20 years, particularly in low- and middle-income countries (LMICs; (Asher & Pearce, 2014). Preschool-age children often exhibit wheezing with viral infections, but only about 50% of them have asthma characteristics at school age (Asher et al., 2020). Therefore, asthma population-based studies typically do not include the preschool age group.

When defining asthma prevalence among children, in the past international studies have depended on epidemiological surveys that focus on self-reported or caregiver-reported symptoms, rather than on doctor-diagnosed asthma (Uphoff et al., 2017; Ferrante & La Grutta, 2018). In particular, wheezing was considered the most important asthma-identifying symptom (Douwes & Pearce, 2014). However, although wheezing and asthma are closely associated, wheezing is not, in itself, a sufficient indicator of asthma (Uphoff et al., 2017).

To address asthma prevalence among children, two population studies of asthma across at least two regions were conducted: the International Study of Wheezing in Infants (EISL; (Bianca et al., 2009) and the International Study of Asthma and Allergies in Childhood (ISAAC; (ISAAC

Steering Committee, 1998; Asher et al., 2020). The EISL covered infants in two countries, while the ISAAC encompassed most regions in the world. As the EISL focused only on children's first year of life, findings from the ISAAC study are presented in this section.

The design of the ISAAC comprises three phases. The survey studied the prevalence and severity of asthma in children living in different countries using a standardised questionnaire that obtained baseline data on prevalence trends and compared data between countries. Phase 1 (1992–1996) used simple written questionnaires for two age groups and was completed at 156 collaborating centres in 56 countries with a total of 721,601 children. In the 13−14 age group (n = 463,801), 155 centres from 56 countries participated, of which 99 centres in 42 countries completed a video questionnaire. For children ages 6−7 (n = 257,800), there were 91 collaborating centres in 38 countries. Children ages 6−7 took the questionnaire home to be completed by their caregivers, and 13- to 14-year-old children completed the questionnaire themselves (Asher et al., 2020). The findings indicated the mean worldwide symptom prevalence of current wheezing in the previous 12 months to be 13.2% among children ages 13−14 and 11.1% among children ages 6−7 (Strachan et al., 1997; ISAAC Steering Committee, 1998). The highest prevalence rates were recorded in New Zealand (28%), the Republic of Ireland (27.9%) and the UK (27.1%). The lowest prevalence rates were observed in Albania (3%), Greece (4.3%) and China (5.1%), (Pearce et al., 2007). Wide variations of asthma prevalence were noted in countries that share genetic similarities, highlighting the relevance of environmental factors in asthma development. However, a striking feature of the findings was the high rate of asthma symptoms in English-speaking countries, raising the question of the validity of the questionnaire across varied languages and cultures. In contrast, there were variations of prevalence rates within and between countries sharing the same language, such as Spanish and Portuguese. Previous studies supported that these prevalence variations were unlikely to be caused by language interpretation, because the video questionnaire conducted at 66 international centres using the local language and at 33 European centres using the English language yielded results that were similar to those of the written questionnaire (ISAAC Steering Committee, 1998; Lai et al., 2009).

Phase 2 (1998–2004), which took place five years after the first phase, surveyed children ages 8−12 from 22 countries to assess asthma risk factors and the rationale for the prevalence

variation noted in Phase 1. In particular, Phase 2 investigated the role of atopic sensitisation in the prevalence rate variation of asthma symptoms. Data were collected using parental questionnaires (n = 54,439), skin prick tests (n = 31,759) and measurements of allergen-specific IgE levels in serum (n = 8,951). An interesting finding of this phase was the strong link between the prevalence of atopic wheeze (i.e., current wheeze in combination with a positive skin prick test) and economic development ($p = 0.002$). Atopic wheeze is a type of asthma that is triggered by allergens, and it is more prevalent in developed countries than in developing ones. One possible explanation for this link is the hygiene hypothesis, which proposes that modernisation and economic development have led to a decrease in exposure to microorganisms, resulting in an increased risk of allergies and asthma. Another explanation is that increased pollution and environmental factors associated with economic development may play a role in the increased prevalence of atopic wheeze in developed countries. This phase also supported the strong link between obesity and the development of asthma in children (Weinmayr et al., 2014). Childhood obesity was measured using age- and sex-specific body mass index (BMI) cut points from an international data set by (Cole et al., 2000).

Phase 3 (2000–2003), which covered 106 centres in 56 countries, duplicated Phase 1 with a detailed environmental questionnaire to obtain data on possible risk factors for the development of asthma and allergic rhinitis (ISAAC Steering Committee, 2005). It included both centres that participated in Phase 1 as well as centres that did not do so and joined the final phase of the study as new participants. The participants in Phase 3 included 304,679 children ages 13−14 and 193,404 children ages 6−7. The mean worldwide prevalence of current wheezing increased slightly from 13.2% to 13.7% (0.06% per year) among children ages 13−14 and 0.13% per year among children ages 6−7 (Asher et al., 2006). There was a noticeable prevalence reduction in English-speaking countries compared to Phase 1 (-0.51% per year; (Pearce et al., 2007). The percentage of children who were reported to have had asthma at some point in their lives (asthma ever) increased 0.28% per year in the 13−14 age group and 0.18% per year in the 6−7 age group (Pearce et al., 2007; Asher et al., 2020). Data collected in Phase 3 indicated that countries in Latin America and Eastern Europe exhibited a significant increase in prevalence in Phase 3 in both age groups (+0.32%, +0.07%), (+0.26%, +0.005%), respectively. With the

exception of India, all countries with very low prevalence in Phase 1 exhibited a higher prevalence in Phase 3 (Pearce et al., 2007).

A recent study providing a comprehensive analysis of Phase 3 data used individual- and school-level data after controlling for confounders to identify possible causes for variation and increase in asthma prevalence. A strong association was found between the development of wheezing and exposure to current paracetamol use (odds ratio [OR] = 2.06; 95% confidence interval [CI]: 1.97–2.16), early-life antibiotic use (OR = 1.65; 95% CI: 1.58–1.73) and open-fire cooking (OR = 1.44; 95% CI: 1.26–1.65) in the 6−7 age group. For children ages 13−14, an association was found between current paracetamol use (OR = 1.80; 95% CI: 1.75–1.86), cooking on an open fire (OR = 1.32; 95% CI: 1.22–1.43) and maternal tobacco use (OR = 1.23; 95% CI: 1.18–1.27). However, the ORs were less than 2 in most of the associations, with the exception of current paracetamol use in the younger group of children (Silverwood et al., 2019).

Although the ISAAC study was a unique global initiative, this research was conducted 19 years ago; therefore, due to developments in treatment, it may not be as relevant today. Additionally, it only measured self-reported asthma in two age groups consisting of different samples. With the current asthma guidelines, developments in diagnostic measures and the significant improvement in global health literacy, there is a need to conduct up-to-date epidemiological studies to investigate asthma as a public health issue. The variations that existed in the prevalence of asthma and its symptoms across nations identified above opened the door to new epidemiological investigations to advance the understanding of asthma causes at a population level (ISAAC Steering Committee, 1998). This suggests the need for a global study as a step towards gaining insight into asthma prevalence and causes among children of all age groups. The inclusion of children of all age groups would add further data on the prevalence and causes of asthma. Furthermore, epidemiological studies conducted at a country level using an international method must address cultural and language variations by focusing on methodological factors that eliminate bias.

The Global Asthma Network, established in 2012, continued ISAAC's work by building on the same approach and methodology to estimate asthma prevalence, severity, management and risk factors among children of the same age group. Phase 1 of the Global Asthma Network survey

(2017–2020) is considered the first global monitoring of children and adults with asthma since 2003. The first worldwide published findings were anticipated by 2021, although no global data had been published at the time of writing this thesis. Two studies have been published for countries that were part of ISAAC and the Global Asthma Network: Thailand (Chinratanapisit et al., 2019) and Mexico (Del-Rio-Navarro et al., 2020). Mexico reported a 7.9% increase in asthma symptoms. In Thailand, there was a small change between the ISAAC study and the Global Asthma Network study: The prevalence rate among children in the 6−7 age group was 15% in ISAAC Phase 3, compared to 14.6% in the Global Asthma Network study (p = 0.54). In the meantime, the prevalence rate in the 13–14 age group in Bangkok was lower than that in Phase 3 of the ISAAC study (12.5% vs. 13.9%, p = 0.024). The Global Asthma Network data revealed that the prevalence of asthma in Thailand was still higher than 10% of the surveyed population (n = 6,291), despite the regularly updated asthma guidelines and the existence of social media to facilitate access to professional care. The study draws attention to the need to promote the availability of preventive medication such as inhaled corticosteroids (ICS).

2.3.2 Risk Factors

Although asthma can begin at any age, clinically, its initial symptoms usually appear by the age of 5 (Tesse et al., 2018). The perinatal period has been associated with the development of childhood asthma (Section 2.3.2.3). Additionally, there are many risk factors for the development of asthma in children, which range from genetic and environmental factors to characteristics such as sex, obesity and atopy. Atopy is a predisposition to becoming sensitised to diverse antigens and/or allergens and responding immunologically by producing IgE antibodies (Vaillant et al., 2022).

2.3.2.1 Genetics and Atopy

Although they have not been thoroughly clarified, differences in asthma prevalence observed in various ethnic groups across the world can be explained by variations in genetic vulnerability (Ferrante & La Grutta, 2018). According to descriptive genome-wide association studies (Tantisira et al., 2011), being an African American is one of the risks identified with making a child more likely to develop asthma, given the significant association found between specific

genes *ORMDL3* (Orosomucoid like 3), *IKZF3* (Ikaros family zinc finger protein 3) and *GSDMA* (Gasdermin A0) and asthma susceptibility. Data generated from countries with large multi-ethnic populations, such as the United States, reveal the disparity in asthma prevalence between different ethnicities. Notably, according to the Centers of Disease Control an Prevention (CDC), asthma prevalence is 5.6% in white American children and up to 14.3% in African American children (CDC, 2019a), asthma prevalence is 5.6% in white American children and up to 14.3% in African American children. A systematic review (58 studies) of prevalence studies of asthma in the UK found that asthma is more common among children of African descent (15%) compared to white (10.6%) and South Asian children (7.6%; (Netuveli et al., 2005). Asthma was also found to be more prevalent in boys than girls, at least before puberty. This was attributed to the smaller airways in boys, which predisposes them to worsened airway restriction than that experienced by girls of the same age, height and weight (Trivedi & Denton, 2019). The CDC provides data on asthma prevalence in children by sex in the United States. According to the CDC's National Health Interview Survey (NHIS), in 2019, the prevalence of current asthma was higher among boys (9.0%) than girls (7.3%; (CDC, 2019c).

Research has identified some genetic markers that are associated with asthma and early lung function decline. A large meta-analysis of genome-wide association studies—including almost 24,000 asthma cases and more than 118,500 healthy controls—identified nine novel loci or genetic marker locations (Demenais et al., 2018). Earlier large genome-wide association studies that genotyped 10,365 persons with asthma identified a particular gene (*ORMDL3)* that was associated with the onset of childhood asthma at ages younger than 16 years (Moffatt et al., 2010). McGeachie and colleagues (2016) conducted a genome-wide association study to determine the genetic underpinnings of lung function patterns in 581 children with asthma. Risk alleles of some single-nucleotide polymorphisms on chromosome 8 were strongly associated ($p = 6.7 \times 10^{-9}$) with early lung function decline (McGeachie et al., 2016).

A family history of atopy is considered one of the most relevant risk factors for developing asthma in childhood (Ferrante & La Grutta, 2018). The “atopic march” is a pattern that is described clinically in people with atopic disease. It starts as atopic dermatitis (or eczema) in infancy and develops into allergic rhinitis (hay fever) and asthma later in childhood (Bantz et al., 2014). Studies have widely documented the casual association between asthma and atopy.

A longitudinal prospective study followed 217 children in the United States from birth to age 13 to assess the association between asthma and allergen sensitisation (Rubner et al., 2017). The study reported that 65% of children who were sensitised to allergens by the age of one had asthma at age 13, while 40% of children who were sensitised to allergens by the age of five had asthma by age 13. The findings suggest that allergen sensitisation during the first years of life increases asthma risk into adolescence.

2.3.2.2 Obesity

Obesity is also considered a major risk factor for asthma. Childhood obesity is defined by the WHO as being two standard deviations above the growth reference median, and overweight is defined as a median BMI greater than one standard deviation above the WHO growth reference median (WHO, 2021). Several studies consistently support the association of the prevalence of asthma symptoms in children with being overweight or obese (Chatzi et al., 2007; Ahmad et al., 2009; Chen et al., 2013; Papoutsakis et al., 2013; Rzehak et al., 2013; Frey et al., 2015). A US population-based cross-sectional study investigating the association between asthma and obesity in children (Ahmad et al., 2009) collected data from 102,353 children ages 17 and younger. Cut-off criteria for obesity were based on the CDC's 2000 BMI-for-age growth charts for the United States: obese (≥ 95th percentile) and non-obese (< 95th percentile). The prevalence of asthma among obese children was 16.4% compared to 12.9% in non-obese children (OR = 1.33). Furthermore, a birth cohort study monitored more than 12,000 children from birth to 6 years old in eight European countries and reported that children with a rapid weight gain in the first two years of life had a higher risk for asthma incidence within the first six years of life than children with a lower early weight gain (OR = 1.3; 95% CI, 1.1–1.5; (Peters et al., 2018).

Obesity risk is not mediated by a child's own obesity—children whose mothers were obese during pregnancy are at higher risk of having asthma in childhood. A meta-analysis of more than 108,000 participants—mothers and their children ages 14 months to 16 years—reported that maternal obesity and antenatal weight gain were independently associated with an approximately 15% to 30% greater risk of asthma in their offspring. Moreover, maternal weight was significantly associated with asthma in children ($p < .001$; (Forno et al., 2014). Furthermore,

in the United States, a longitudinal retrospective study that included 12,963 children ages 9–14 and their mothers revealed that an asthma diagnosis during childhood or adolescence was reported for 2,694 children (21%) whose mothers were obese. Being antenatal overweight mother (OR = 1.19; 95% CI: 1.03–1.38) and obese (OR = 1.34; 95% CI: 1.08–1.68) were associated with offspring asthma diagnoses (Dumas et al., 2016). Furthermore, obese children tend to have severe asthma (Ahmadizar et al., 2016). A meta-analysis of 46,070 children and adolescents with asthma found that obese children (BMI ≥ 95th percentile) had a significantly higher risk of asthma exacerbation (OR = 1.17; 95% CI: 1.03–1.34) when compared with their non-obese peers.

2.3.2.3 Exposure to Microbes

The incidence of childhood asthma has also been associated with a lack of early microbial exposure. Improved sanitation and increased immunisation rates have reduced children's exposure to microbes and, therefore, have caused alterations in the development of their immune systems, increasing the vulnerability to developing asthma in genetically susceptible children (Ferrante & La Grutta, 2018). However, research suggests that exposure to some microbes in early childhood, such as respiratory viral infections, promotes asthma development (Fishbein & Fuleihan, 2012). A prospective cohort study followed 206 children from age one or younger to age six to evaluate the potential determinants of physician-diagnosed asthma following respiratory syncytial virus during their first year of life. The study found that nearly half of infants (48%, n = 103) with a lower respiratory tract infection caused by respiratory syncytial virus during their first year of life developed persistent asthma at school age (Bacharier et al., 2012). In addition to viral microbes, studies have indicated that exposure to bacterial microbes, such as bacterial pneumonia, can potentially induce asthma exacerbation (Tatum & Shapiro, 2005; Darveaux & Lemanske, 2014; Ferrante et al., 2014).

2.3.2.4 Exposure to Environmental Triggers

A major environmental risk factor for children's asthma is tobacco smoke (Ferrante & La Grutta, 2018). Children's exposure to passive smoke in the prenatal and new-born periods has an adverse impact on immune system and lung development, leading to high asthma incidence.

A population-based prospective cohort study conducted in the Netherlands among 6,007 children examined the associations of maternal and/or paternal smoking during pregnancy with airway resistance, airway inflammation, wheezing patterns and physician-diagnosed asthma in school-aged children (Herman et al., 2015). The study revealed that maternal smoking was associated with greater risks of persistent wheezing (OR = 1.24 [1.01, 1.52]) and asthma (OR = 1.65 [1.07, 2.55]), leading the authors to conclude that maternal smoking during pregnancy was associated with increased asthma risk in school-age children.

Moreover, exposure to tobacco smoke at school age is a major risk factor for exacerbation of asthma and poor asthma control. A case study was conducted among 1,172 Latino and African American schoolchildren ages 8–21 with asthma to assess the relationship between second-hand smoke exposure and asthma outcomes (Neophytou et al., 2018). Participants exposed to second-hand smoke had a higher OR for experiencing asthma exacerbation in the previous year (OR = 1.40; 95% CI: 1.03–1.89) and a higher OR for poor asthma control (OR = 1.53; 95% CI: 1.12–2.13). Exposure to second-hand smoke was associated with greater odds of asthma exacerbation and poor asthma control regardless of the level of exposure that was measured using serum nicotine levels.

Increased asthma prevalence among children in industrialised countries highlights the role of air pollution in inducing asthma (Wolff et al., 2012). Extensive research suggests that exposure to indoor and outdoor pollution has a strong link with asthma exacerbation, hospital admission rate and reduced lung function among children. A study on the disease burden of childhood asthma in 18 European countries involving 63,442,419 children ages 1−14 demonstrated that 33% of new cases of asthma were attributed to air pollution (Khreis et al., 2019). A recent systematic review and meta-analysis (N = 269,840 children, 25 studies) established statistically significant associations between long-term exposure to outdoor air pollution—specifically, black carbon—and the development of childhood asthma between birth and 18 years old (Khreis et al., 2017). The overall random-effects risk estimate (95% CI) was 1.08 (1.03, 1.14). Gehring et al. (2015) conducted a population-based birth cohort study in three European countries to prospectively investigate the association between children's birth addresses and their addresses at the time of asthma onset. The study included more than 14,000 children from the Netherlands, Germany and Sweden. Children were followed up with at ages one, two, four, six to eight, 10–

12 and 14–16. Air pollution monitoring campaigns were conducted in each study area. The study found that increased exposure to nitrogen dioxide (NO_2) at the birth address was linked with higher asthma incidence at ages 14–16 years (OR = 1.13; 95% CI: 1.02–1.25; (Gehring et al., 2015).

A cross-sectional study of 3,168 Chinese schoolchildren found that air pollution—specifically, particulate matter—was significantly associated with lung function impairment in children (Gao et al., 2013). Children's lung functions were measured for forced vital capacity (FVC, $p = .182$), forced expiratory volume in 1 s (FEV1, $p = .014$), forced expiratory flow between 25% and 75% of FVC (FEF25–75, $p \geq .001$) and forced expiratory flow at 75% of FVC (FEF75, $p \geq .001$).

2.3.2.5 Risk Factors Related to Pregnancy and Delivery

Maternal diet was also considered a risk factor for asthma development. A maternal diet with enough vitamin E, zinc, folic acid and polysaturated fatty acids has been implicated as a protective measure against the development of childhood asthma (Bisgaard et al., 2016). Conversely, a high level of maternal sugar intake was linked with increased asthma risk in offspring (Bédard et al., 2017). A longitudinal population-based birth cohort study followed 8,956 UK mother-and-child pairs from pregnancy to the child's age of seven to explore the association between maternal sugar intake and asthma in the offspring (Bédard et al., 2017). After adjustment for potential confounders, a positive association was found between maternal free sugar intake in pregnancy and doctor-diagnosed asthma in children (OR = 2.01; 95% CI: 1.23–3.29; $p = .04$). It is worth mentioning that this association was not confounded by early childhood sugar intake.

A hospital-based case control study that included 548 cases and 814 normal controls in Shanghai explored the associations between periconceptional and gestational exposure to folic acid and the risk of childhood asthma. The authors found that periconceptional folic acid supplementation was associated with an increased risk of childhood asthma, with an odds ratio (OR) of 1.73 (95% confidence interval [CI]: 1.29-2.32, $p<0.001$). The association was particularly strong among children whose mothers took folic acid supplements during the first trimester of pregnancy, with an OR of 2.01 (95% CI: 1.35-2.98, $p<0.001$; (Chu & Zhang, 2022).

The use of caesarean section for an infant's delivery and the low birth weight of a new-born are also associated with a childhood asthma diagnosis. A systematic review and meta-analysis of 37 studies involving more than 5 million participants investigated the association between caesarean section and childhood asthma diagnosis. In the final analysis, the review reported a statistically significant relationship between caesarean section, either elective or emergency, and childhood asthma diagnosis with a relative risk of 1.20 (95% CI: 1.15–1.25, $p < 0.001$; (Darabi et al., 2019). However, the possibility of including an individual patient multiple times in the study was one of the limitations of this review.

A cross-sectional study explored the relationship between birth characteristics, including preterm birth and low birth weight, and asthma among 90,721 children ages 0–17 (Zhang et al., 2018). After controlling for confounders, children who were born preterm were 1.64 times (95% CI: 1.45–1.84) more likely to develop asthma than those who were born at term. Similarly, children who had a low birth weight were 1.43 times (95% CI: 1.25–1.63) more likely to have asthma, and the OR increased to 1.77 for children who were both preterm and with a low birth weight.

2.3.3 Childhood Asthma Diagnosis

An asthma diagnosis among children is made depending on the history of asthma symptoms and on the basis of a physical examination and lung function testing. Childhood respiratory symptoms, family history of asthma and history of allergic rhinitis or atopic dermatitis increase the probability that respiratory symptoms are associated with asthma (GINA, 2022). As asthma symptoms in early childhood (0−6 years) resemble the symptoms of other respiratory conditions, asthma diagnosis in this age group is challenging (Trivedi & Denton, 2019), and it is well established that asthma can be underdiagnosed and undertreated in this age group (Galant et al., 2006; Uphoff et al., 2017). Many countries consider asthma diagnostic tests performed before the age of five to be misleading (Saglani & Menzie-Gow, 2019) because children younger than five cannot perform the tests well enough to gain accurate results, as successful production of a forced expiratory flow manoeuvre is age-dependent. In Ireland, children cannot be officially diagnosed with asthma until the age of five (Asthma Society of Ireland, 2022b). In a community-based sample of 102 children, 86% (n = 88) had a physician-assigned clinical

diagnosis of asthma; however, only 60% (n = 53 of 88) had objective test scores (Yang et al., 2017).

Children in late childhood (7−12 years) can more reliably engage with diagnostic tools. In addition, symptoms in this age group are more likely to be triggered by allergies than by viruses (Murray et al., 2017; Trivedi & Denton, 2019). Another factor is that exercise-induced asthma is more present at this age, either because of a change in symptom presentation or a tendency to exercise more. A physical examination of children with asthma often produces normal findings except for the presence of expiratory wheezing on auscultation, which can be heard with forced expiration. However, due to the reduced airflow, this wheezing can be absent in most cases, even during severe asthma exacerbation; although other respiratory symptoms are usually present in such conditions (GINA, 2022).

2.3.3.1 Lung Function Tests and Inflammatory Markers

Lung function tests are a set of tools used to diagnose and monitor asthma by assessing the limitation of expiratory airflow. Such tests check how well the lungs work. It is worth noting that lung function test results can vary from normal to severely obstructed in the same child and can also fluctuate from time to time in healthy individuals (GINA, 2022). Moreover, the severity of obstruction does not always correlate with asthma symptoms; in fact, asymptomatic children may have severe lung obstruction. Schifano et al. (2014) found low concordance between asthma symptoms and lung function results in an American population of 894 schoolchildren ages 5−19, and a higher grade of asthma severity was given when spirometry was taken into account ($p < .0001$). Therefore, regular lung assessment is essential (Schifano et al., 2014).

The most basic test for detecting and measuring airway obstruction is spirometry, which can be used to diagnose asthma by measuring the volumes of inspired and expired air. However, spirometry can produce normal values despite the presence of severe symptoms, making it more accurate as a monitoring tool for children with asthma after an asthma diagnosis has been established using other assessment tests (Murray et al., 2017). Moreover, the practical application of spirometry in children is even more demanding due to the challenge presented to technical experts in conducting reliable and reproducible tests. This is because the reliance will

be on the ability of the child to adequately perform voluntary manoeuvres (Saglani & Menzie-Gow, 2019). A cross-sectional descriptive study by Ayuk and colleagues in Nigeria revealed that familiarity with the use of a spirometer among paediatric residents in Nigeria was suboptimal, as only 18.2% (12 participants) were familiar with the tool (Ayuk et al., 2017). According to a 2017 GINA report, the use of spirometry for childhood asthma diagnosis is poorly applied worldwide (GINA, 2017).

The peak expiratory flow rate (PEFR) measurement is used to monitor asthma by assessing a patient's ability to blow air out of their lungs. The child should blow air as hard as possible into a handheld device called a peak flow meter (PFM). The resulting peak flow meter score indicates how narrow the airways are, reflecting worsening symptoms, exacerbation of symptoms or whether medication is working (Health Service Executive, 2022). PEFR values vary depending on the meter used and the timing of assessment; therefore, it is advisable to compare its measurement with the best personal value using the same meter (Gallucci et al., 2019). To prospectively evaluate the lung function of 89 Korean children with asthma (< 18 years) using PEFR, Kim et al. (2021) recorded participants' PEFR on a daily basis for at least one year. The authors reported that the PEFR in children with asthma was 1.9% lower in autumn than in winter (95% CI: −3.73 to −0.15; (Kim et al., 2021), highlighting the seasonal pattern of asthma exacerbation discussed in Section 2.5. The GINA specifically recommends the use of either the PEFR or spirometry in the diagnosis of asthma in children older than five years (GINA, 2022). Normal parameters of lung function tests are displayed in Table 2.1.

Another test that can be used to assist with asthma diagnosis is impulse oscillometry. Compared to spirometry, these tests can be easily performed with children, since measurements are done with tidal breathing, which requires minimal patient cooperation (Galant et al., 2017; Gallucci et al., 2019). In a cohort study of 117 children in the United States, impulse oscillometry proved to be more useful than spirometry in diagnosing asthma among schoolchildren (p = .03; (Komarow et al., 2012). In their review, Galant et al., 2017 reported that oscillometry detected airway obstruction in both central and peripheral airways and was more useful in asthma diagnosis than spirometry (Galant et al., 2017). Additionally, when administered to pre-schoolers, oscillometry has been demonstrated to predict lung function at school age. Oscillometry was used to prospectively assess lung function among 255 children ages four to

seven, and their lung function was reassessed at ages 10–12. The researchers found that abnormal preschool oscillometry was associated with asthma and poor lung function in adolescence (OR = 9.2; 95% CI: 2.7− 31.7; (Lajunen et al., 2018).

As a supplementary diagnostic tool, fractional exhaled nitric oxide (FeNO) measures the level of NO in an exhaled sample of a child's breath to indirectly measure airway inflammation (Yang et al., 2019). This practically useful test can also help determine whether steroid medications might be considered as a treatment for the child's asthma (Menzies-Gow et al., 2020) and can be administered quickly to school-aged children (Yang et al., 2019). Another commonly performed lung function test is lung volume testing, which measures the volume of air inside the lungs, including the air that remains after normal breathing (American Lung Association, 2020). Oxygen saturation, which is measured using a pulse oximeter that records the amount of oxygen in the blood, is another simple test used in conjunction with other tools to diagnose asthma. Moreover, an allergy test can examine the presence of atopy, which—although it is not an asthma-specific test—reflects the increased probability of having allergic asthma (GINA, 2022).

Overall, there is no gold-standard confirmatory test for asthma, despite the use of objective tests. The diagnostic tests reported in research studies provide only indicative evidence of asthma. Medical history, clinical examination, supportive diagnostic tests and frequent assessment of response to treatment remain the ultimate guides to accurate diagnosis (Saglani & Menzie-Gow, 2019).

Table 4.1. Lung Function Measures Used for Asthma Diagnosis Among Children According to GINA Guidelines

Test	**GINA Normal Parameters**
Spirometry	FEV1/FVC < .90
PEFR	Variability > 20%*
FeNo	> 50 ppb has been associated with good short-term response to medication
* Calculated from twice daily readings (best of each time)	

2.3.4 Childhood Asthma Treatment and Management

The goal of asthma management is to achieve good symptom control, reduce asthma-related mortality exacerbation and maintain normal activity levels (GINA, 2022). Asthma treatment can manage symptoms and prevent exacerbation. Depending on the severity, a child's asthma can be managed effectively through non-pharmacological measures, such as trigger avoidance and self-management education, and pharmacological intervention, such as the regular use of medication (Tesse et al., 2018; Cloutier et al., 2020; Global Initiative for Asthma, 2022).

Pharmacological treatment involves two key types of medication: the daily controller medication and the as-needed use of a short-term reliever (GINA, 2022). Controller medications, which include ICS, leukotriene modifiers, combination inhalers, theophylline and immunomodulatory agents, reduce the inflammation in a child's airway and prevent future exacerbation. Short-term reliever medications, which act within minutes and last several hours, are administered as needed when symptoms worsen and are also used to prevent exercise-induced bronchoconstriction. These medications include short-acting beta-agonists **(**bronchodilator medications) that can rapidly widen airways to ease symptoms of exacerbation and oral intravenous corticosteroids that relieve airway inflammation. A child's asthma control level is assessed based on the presence of asthma symptoms (the child has few or no symptoms), the degree of activity limitation and the use of controller medications (minimal or no need for quick-relief inhalers). Therefore, an essential indicator of successful treatment is the reduction or, ideally, elimination of the need for reliever medications (GINA, 2022).

2.3.4.1 Self-Management

2.3.4.1.1 Self-Management Education

Self-management aspects of childhood asthma include asthma education and an asthma action plan (AAP). The concept of asthma self-management education is not new, and this type of information can be delivered to children and/or caregivers through school-based asthma education programmes. Childhood asthma self-management programmes can range from home visits to technology-guided programmes that help children assess and respond to their own symptoms. To prospectively evaluate the impact of an asthma self-management application on child health outcomes, Nkoy et al. (2019) implemented a self-management application for children (N = 237) with asthma in the United States. Authors reported significant positive longitudinal changes in children's quality of life ($p < .001$) and the number of school days missed ($p \leq .001$) after 12 months. The hospitalisation ratio declined by 0.68 (95% CI: 0.49–0.95). Additionally, average oral corticosteroid use was 0.74 days before the application of self-management and 0.51 days after the application of self-management, with an adjusted hospitalisation ratio between pre- and post-intervention of 0.74 (95% CI: 0.61–0.91; (Nkoy et al., 2019).

Nutrition and exercise are other aspects of childhood asthma self-management. A systematic review of the literature (29 studies) explored the effect of exercise training in schoolchildren with asthma (N = 1,045 children ages 6−18). The review reported that short-term exercise (two 60-minute trainings per week for a minimum duration of three months) improved lung function and symptom control (Wanrooij et al., 2014). A major influence in optimising care for children with asthma is understanding who carries the primary responsibility for asthma management throughout childhood. In early childhood, caregivers manage nearly all asthma control, and interventions focus mainly on caregiver asthma education (Rehman et al., 2020). Appropriate education of parents and other caregivers of children with asthma has clearly been demonstrated to help achieve asthma control (Kelso, 2016); see Section 2.3.4. At school age, children begin to form some level of autonomy over their asthma care, but they remain reliant on adults for assistance; hence, school-based interventions that involve caregivers might be appropriate (Rehman et al., 2020). The 2018 Annual Asthma Survey in the UK found that approximately 20% of caregivers did not seek medical advice during acute asthma exacerbation, highlighting

large gaps in education (Asthma UK, 2018). Parents of children with asthma need education about the child's disease and how to treat it. This typically involves a discussion with the parents about the pathophysiology of asthma and the use of controller and rescue medications, including education on appropriate medication delivery devices, such as metered dose inhalers with spacers, dry powder inhalers and nebulisers. This discussion can be undertaken at the time of diagnosis and reinforced at subsequent visits (Kelso, 2016). Providing asthma education to parents of children with asthma aids in achieving the goals of asthma treatment among children in terms of less frequent symptoms, reduced activity limitation and rare instances of exacerbation (Wong et al., 2013; Sheares et al., 2015).

2.3.4.1.2 Asthma Action Plans

An AAP is a written document that contains a step-by-step guide to managing asthma and recognising warning signs and symptoms. It is usually completed by the child's general practitioner and contains a list of medications and when to take them, when to increase preventive ICS medication, how to tell whether asthma is getting worse, how to act in case of exacerbation and when to seek medical help through the stated emergency contact numbers (Asthma Society of Ireland, 2022a; GINA, 2022). The AAP also acts as a reminder for the daily use of ICS (GINA, 2022). For children, the symptom perception of airway obstruction might be weak and, therefore, the AAP encourages children to become involved in self-management by daily monitoring of their asthma using a PFM, which can detect airway obstruction at an early stage of the exacerbation (Lakupoch et al., 2018). An AAP can also serve as a link across multiple caregivers, such as school nurses and general practitioners (Lakupoch et al., 2018).

Although providing a written AAP is recommended by GINA guidelines (GINA, 2022), its use among children remains controversial. Studies in the past decade have indicated that adding an AAP can act as a vehicle for providing self-management instructions between children and their caregivers but is no better than standard treatment and education and is not effective as a stand-alone treatment guide (Sunshine et al., 2011; Wong et al., 2013; Sheares et al., 2015). Another study suggested that AAPs discourage visits to a general practitioner or a hospital emergency room (ER; (Kelso, 2016).

2.4 Global Burden of Childhood Asthma

2.4.1 Lifelong Burden

Although asthma can develop at any stage in life, it generally appears in childhood (GINA, 2022). It is worth mentioning that children with severe asthma are at higher risk of developing chronic respiratory pulmonary disease (Tai et al., 2014; Bateman et al., 2015; Bui et al., 2018). The Asthma Melbourne Study, which began in 1964 and aimed to explain the natural spectrum of childhood asthma, indicated that fewer than half of the participants with persistent asthma at age six (47%, n = 53) and the majority with severe asthma at that age (75%, n = 62) still had asthma symptoms at the age of 50 (Tai et al., 2014). Therefore, asthma can be considered a lifelong disease, particularly for individuals with severe cases.

The Global Burden of Disease study estimates the toll taken by various diseases by assessing deaths and disability-adjusted life years (DALYs; (Asher et al., 2020). DALYs are considered an essential measure in estimating the global burden of diseases and are compiled using the sum of two components: years of life lost and years of life with disability (Gao et al., 2015)Asthma is in the top 20 causes of years of life lived with disability (Global Asthma Network, 2018). Overall, when assessing disease burden using DALYs, asthma represents the second most important respiratory disease after chronic obstructive pulmonary disease (Ferrante & La Grutta, 2018). In 2019, the global DALY rate due to childhood asthma was 5.1 million (95% CI: 3.4 million–7.5 million). The highest DALY rate was among children and youth ages 5–19 in high sociodemographic regions. High BMI and occupational asthma genes were important associated risk factors in this age group (Zhang & Zheng, 2022).

2.4.2 Hospitalisation

Asthma is the main cause of hospitalisation among children younger than five years old (Ferrante & La Grutta, 2018) and is ranked as the third leading cause of hospitalisation in children younger than 15 years old (CDC, 2018a). The comorbidities of childhood asthma include allergic rhinitis, loss of lung function and mental illness (Shankar et al., 2019; Davies et al., 2021). Global data indicate a high number of hospital admissions for children with asthma compared to adults. An American study revealed that the asthma-related hospitalisation rate

was 104 in 100,000 children in 2017 (Ebell et al., 2019b). More than 6,000 asthma hospitalisations were recorded among children in Canada in 2015–2016 (Canadian Institute for Health Information, 2022). Additionally, a Canadian study reported on a 16-year trend in asthma hospitalisation among children from 2002 to 2017 (Lee et al., 2022). In the study period, there were 150,256 childhood asthma hospital admissions, revealing a 56% decline in such admissions from 79.2 per 100,000 children in 2002 to 32.7 per 100,000 children in 2017. In a descriptive study that investigated hospital admissions among Brazilian children ages 0–19 between 1998 and 2019, the total number of admissions due to asthma was 3,138,064, with the greatest number of hospitalisations among children ages 0–4, followed by children ages 5−9 (Fonseca et al., 2021).

In a population of Latino children ages 1–18 hospitalised for an asthma exacerbation (N = 101), 37% (n = 36) had at least one asthma-related hospital admission during the year following their initial admission (Rodríguez-Martínez et al., 2014). Although national hospital admission statistics are scarce in LMICs, there is a correlation between asthma prevalence and admission rates (Asher et al., 2020). The ISAAC study revealed a positive correlation between reduced asthma prevalence and childhood hospitalisation (Global Asthma Network, 2018). According to the 2018 Global Asthma Report, asthma contributes to 0.6% of all hospital admissions for both adults and children. However, drawing specific data on global asthma admission rates is challenging, as the routine collection of asthma admission information is limited (Global Asthma Report, 2018).

2.4.3 Mortality

Asthma causes a mortality burden of approximately 1,000 deaths daily among both children and adults (Global Asthma Network, 2018). Although adults are five times more likely to die from asthma than children (National Center for Health Statistics, 2020), asthma mortality among children is strongly linked with severe symptoms and hospitalisation (Anderson et al., 2008). The ISAAC study indicated a significantly positive correlation between childhood asthma mortality and the prevalence of severe asthma symptoms among both 6- and 7-year-olds (29 countries, $p = 0.02$) and 13- and 14-year-olds (38 countries, $p = .04$; (Anderson et al., 2008). According to the latest Global Burden of Disease study covering 204 countries, 12,900 children

died from asthma in 2019, 27.9% (n = 6,100) of whom were ages 1−4, 13.2% (n = 1,700) were ages 5−9 and 16.4% (n = 2,100) were ages 10−14 (Zhang & Zheng, 2022). Generally, there has been an overall global reduction in childhood asthma-related mortality. In 2015, 400,000 people died from asthma, a reduction of 26.7% compared with 1990. The decrease in age-standardised death rates was 58.8%, reflecting improved access to healthcare services and the use of ICSs (Soriano et al., 2017). Fonseca et al. (2021) reported that the total number of registered deaths caused by asthma between 1998 and 2019 in Brazil was 1,977 (the percentage of the total population is not reported), with no significant differences noted between the years (p = .220).

2.4.4 Economic Burden

The economic burden of childhood asthma encompasses both direct healthcare costs and the loss of productivity among families and societies (Serebrisky & Wiznia, 2019). An understanding of the financial aspect of asthma is important not only for individuals with asthma but also for national health management administrators who decide how to accurately allocate economic resources. Studies addressing the economic burden of asthma must consider both its direct and indirect costs (Ernst, 2006; Bahadori et al., 2009). Direct medical costs reflect inpatient and outpatient care and medication (Lee et al., 2011), while indirect costs refer to the output lost due to reduced productivity because of morbidity or mortality (Lee et al., 2011). Indirect costs related to school losses are unquantifiable, as they are related to reduced quality of life, limited physical activities and low academic performance (Ferrante & La Grutta, 2018). According to a surveillance study conducted by the CDC, children ages 0–17 with asthma had higher rates of doctors' visits, hospital outpatient visits and ER visits than adults with asthma ages 18 years and older in the United States (Moorman et al., 2012).

Results of several studies reveal varied figures for childhood asthma economic expenses in different countries, such as France (Pamuk et al., 2021), the United States (Perry et al., 2018), Iran (Sharifi et al., 2018), the UK (Lewis et al., 2016), South Korea (Lee et al., 2011), Italy (Antonicelli et al., 2004), Canada (Ungar & Coyte, 2001) and Switzerland (Szucs et al., 1999). In France, the direct cost of managing a child with severe asthma was €3,982 over six months in 2017, with 65% of the cost attributed to medication. The direct cost increased to €6,716 for a child who requires omalizumab, an injectable medication for children ages six and older with

moderate to severe asthma. In the United States, the total direct cost of childhood asthma was US $5.92 billion in 2013, with annual costs per child ranging from US $3,076 to US $13,612 (Perry et al., 2019). In Iran, the annual total childhood asthma-related costs per child were US $367.97 ± $23.06, with the highest proportion of the cost belonging to medication (69%) and the lowest to ER treatment (2%; (Sharifi et al., 2018).

2.4.5 Social Burden

Asthma is associated with social burden for both children and their caregivers (GINA, 2022). Quality of life is a subjective concept that encompasses the physical, emotional and social well-being domains (Rehman et al., 2020) and it measures the impact of certain conditions in a social well-being context. Several studies have addressed the negative impact of asthma on children's quality of life (Williams et al., 2000; Schmier et al., 2007; Luskin et al., 2014; Banjari et al., 2018).

Ekim and Ocakci (2016) conducted a systematic review that included 22 studies (N = 3,666). They described the caregiver burden experienced by parents caring for children with asthma as having a high level of physical, psychological, emotional, behavioural and financial cost (Ekim & Ocakci, 2016). The review found that asthma has a negative impact on the quality of life of caregivers of children with the condition, with the primary factor being asthma severity (Rehman et al., 2020). The more severe a child's asthma, the more need there is for healthcare access, medication, environmental attention and emotional support, requiring additional effort from the caregiver (Williams et al., 2000; Cerdan et al., 2012; Silva et al., 2015). Currently, with the trend in care shifting from hospital to home, parents are required to actively participate in the care of their asthmatic children. This situation was accelerated during the COVID-19 pandemic, because access to healthcare centres declined during the lockdown periods. The additional time and expense required by children with asthma place the caregiver at risk of a reduced quality of life, causing a significant social burden (Cerdan et al., 2012; Cheezum et al., 2013).

Lost school days affect study performance, which negatively influences children's psychological well-being. An asthmatic child with an exacerbation loses, on average, three to

five school days (Akinbami et al., 2016; Sullivan et al., 2018). A descriptive study in 35 American states (Hsu et al., 2016) examined asthma-related school absence among children with asthma (N = 8,881). More than 50% of children (n = 4,529) missed at least one school day because of asthma in the past 12 months. Children who were absent because of asthma were more likely to report asthma exacerbation (OR: 1.50; 95% CI: 1.34–1.69) and to have to seek urgent or emergency health care (OR: 3.27; 95% CI: 2.44–4.38). School absence of ≥ 5 days was associated with asthma-related hospital admission (OR = 2.88; 95% CI: 1.69–4.90).

Asthma-related school absenteeism can affect schoolchildren's academic performance. A systematic review (N > 5,000 schoolchildren) that explored the relationship between asthma and academic performance described school absence as a mediating factor (Schneider, 2020). An Australian population-based matched case-comparison cohort study of children and young people ages ≤ 18 years admitted for asthma (Mitchell et al., 2022) reported that young males admitted for asthma are at a 13–15% higher risk of not achieving math numeracy scores (95% CI: 1.04–1.22) and reading scores (95% CI: 1.07–1.23) compared to their peers. Young females admitted for asthma had a 21% higher risk of not completing year 11 (95% CI: 1.09–1.36) and a 33% higher risk of not completing year 12 (95% CI: 1.19–1.49) compared to their peers.

A Nigerian study conducted among 240 schoolchildren—120 children with asthma as subjects and 120 children without asthma as controls—revealed that the average number of missed school days was nine for the subjects and three for the controls ($p < .001$). However, there was no significant association between school absence and academic performance among subjects ($p = 0.14$) and controls ($p = 0.44$; (Nduagubam et al., 2017).

Participation in physical activity is important for children's physical and psychological development and self-image. However, the physical activity level of schoolchildren with asthma varies in different stages of the disease. A case-control study in Taiwan compared and quantified the physical activity of children ages 8–12 with asthma (n = 120) and without asthma (n = 262). Children with asthma were less active than their healthy peers ($p = .002$), and among children with asthma, physical activity was associated with the severity level of their condition. Children with moderate to severe asthma were more likely to be inactive (OR = 3.2; 95% CI: 1.5–8.4; (Lam et al., 2016). There is a tendency for children with asthma to avoid exercise because of

fear of worsened symptoms. In a qualitative study that elicited the views of 45 adolescents (age 13.1 ± 0.9 years; 26 with asthma) regarding exercise and asthma, fear of an asthma exacerbation was described as the main barrier to exercise (Winn et al., 2018). Despite this, the majority of adolescents with asthma (81%) pointed to exercise as their most enjoyable activity.

2.5 Role of School Nurses in Asthma Management

School nursing is a speciality practice within the profession of nursing that has changed alongside advancements in public health, education, medicine and nursing. The evolution of school nursing demonstrates that the nursing profession has responded effectively to the changing needs of society. It is also interconnected with other disciplines, such as education, public health and social services, in a way that has a positive impact on students, their families and their communities (Selekman et al., 2019). Throughout history, the role of the school nurse has been defined and refined by determining the educational preparation and experience needed for the school nursing profession, thus addressing the needs of schoolchildren and youths (National Association of School Nurses (NASN), 2016).

Children older than five years old spend much of the day at school away from their parents. Moreover, they are exposed to new triggers and additional stressors at school, such as physical activities and environmental and food allergens (Larsen et al., 2016; Dondi et al., 2017). With these factors in mind, school-age children are particularly vulnerable to asthma exacerbation (Perry et al., 2019), which increases at the start of the school year, with September being the month of peak exacerbation (Larsen et al., 2016; Dondi et al., 2017). Children often struggle to control their asthma in a school setting (Kakumanu et al., 2017). School nurses are in an optimal position to address the health needs of students with asthma, thus promoting school attendance and academic achievement (Maughan et al., 2017). Moreover, school nurses can provide a significant link between health and education for school-age children.

Studies recommend that school nurses have a well-defined approach to tackling asthma (Russell et al., 2021), which can include assessing students' health statuses, minimising exposure to triggers and assessing the knowledge and skills of students, families and non-medical staff in order to provide relevant health education accordingly. School nurses are responsible for

developing individualised health plans in collaboration with the student's family and physician. They also play a significant role in assessing the degree of medication compliance and, more importantly, responding to asthma medical emergencies (Rodriguez et al., 2013; Hoekstra et al., 2016; Russell et al., 2021).

In an ideal situation, the primary care physician completes an individualised AAP that provides details on the child's current medical status along with their daily medication and exacerbation prevention medication. The AAP should also indicate symptoms of controlled and worsening asthma. The role of the school nurse is to interpret this AAP for the school team and to use it when caring for a student with asthma. Missing, incomplete or outdated AAPs are among the barriers to effective asthma management in schools (McClure et al., 2020). The school nurse can have proactive communication with parents and caregivers to obtain an AAP from the primary care physician and can also consider sending a reminder to the physician.

When serving as a team member, the school nurse can assist in environmental trigger reduction through early identification of common asthma triggers and signs and symptoms of asthma exacerbation as well as by providing preventive interventions (McCabe et al., 2019). School nurses are authorised to inspect the school setting and report the presence of any triggers. Common triggers at schools are moulds from excess moisture in the building, dust mites, second-hand smoke, and cleansing agents such (Allergy and Asthma Network, 2020; American Academy of Allergy Asthma & Immunology, 2020; CDC, 2020). It is important to communicate such triggers to the school nurse, as trigger avoidance is a key factor in exacerbation prevention (CDC, 2018). Additionally, exacerbation prevention strategies are a vital topic that school nurses should consider when developing health education programmes for students, families and school staff (Russell et al., 2021). Although asthma exacerbations can occur at any time throughout the year, several studies have reported seasonal patterns of asthma exacerbation, with fall being the peak season (Cohen et al., 2014; Tosca et al., 2014). A 10-year retrospective population study investigated the seasonal variation of asthma among 919,873 children ages 2 to 15. The study revealed a 2.01-fold increase in asthma exacerbation and a 2.28-fold increase in bronchodilator medication prescription in September compared to August. Among children ages 6−9, asthma-related primary care visits increased 1.60-fold in September

(Cohen et al., 2014), demonstrating the importance of exacerbation prevention when students return to school after the summer holiday.

Providing health education is one of the main roles of school nurses. There are important points to consider, as school nurses will personalise health education programmes either for families or school staff. Assessing a family's or school staff member's knowledge, skill and self-efficacy levels regarding asthma management is essential to identify gaps in knowledge that the school nurse can supplement (Russell et al., 2021). Having a student with asthma demonstrate how to use an inhaler may reveal a knowledge gap. The correct inhaler technique was identified by school nurses as a common need for students with asthma, as it has an impact on the administration of daily preventive medication (Everhart et al., 2020). Other factors school nurses should consider when developing health education plans for families are health literacy levels, language barriers and cultural beliefs (Russell et al., 2021). Providing health education to school staff is as important as educating students. In countries where school health services are available, school nurses are the main drivers of this education (Van Der Pol et al., 2020). However, many countries do not have school nursing services, leaving the care of schoolchildren with asthma to teachers or administrators (Alkhamis & Hashim, 2019). A systematic review conducted by Jaramillo and Reznik suggests that professionals working in schools in the United States (N = 2,267) have insufficient knowledge about the negative impact of allergic diseases on children's lives and families (Jaramillo & Reznik, 2015). It is the role of school nurses to educate non-medical staff at school so that they can manage students' symptoms when the school nurse is not available.

When routine asthma management protocols are altered, school nurses take a proactive role in discussing the new guidelines with students and families. During the COVID-19 pandemic, to avoid aerosolisation of the virus, the CDC recommended that only students who did not have access to inhalers could use a nebuliser at school (CDC, 2021). Russell et al. (2020) found that 51% of parents in the study sample had a child with asthma. Of those children, 99% had a prescribed inhaler and 41.5% had a prescribed nebuliser. Twenty-two per cent of parents were unaware of the new CDC guideline and more than 37% of them had not discussed this updated guideline with their primary physician (Russell et al., 2020). This illustrates how important it is

for school nurses to communicate updated guidelines related to asthma management to families and school staff.

Asthma medication adherence can have an impact on clinical outcomes (Alreshidi, 2015). Once the school nurse identifies barriers to medication adherence, strategies can be developed to tackle these challenges. The school nurse should consider taking a proactive role in communicating with the primary care physician to clarify the prescribed medication and collaborating with school staff for additional evaluation (Russell et al., 2021). Additionally, the school nurse can monitor the child's progress when they are on specific medication.

Responding to asthma exacerbation is a core role of nurses in the school setting. School nurses should ensure access to emergency medication, as not all students with asthma carry a quick-relief inhaler. Depending on the region's laws and regulations, the school nurse can advocate for having a stock of emergency medication at school. Doing so can improve access to medication for children who do not self-carry, forget to self-carry or are experiencing their first asthma exacerbation at school (CDC, 2018b; O'Rourke et al., 2020).

2.6 Asthma Prevalence Among Children in Oman

The discovery of oil in Oman in 1964 put the country on a path of rapid social and economic development, causing a shift towards Westernisation. Oman has witnessed remarkable growth since the 1970s (Al Riyami et al., 2013). This growth is also attributed to the urbanisation of the country, which has been linked to increased asthma prevalence. The mechanism by which urbanisation affects asthma prevalence is not fully clear. However, environmental and lifestyle factors—for example, diet, sedentary lifestyle, antibiotic use, air pollution and migration—that originate with urbanisation are identified as risk factors for increased asthma prevalence in urban districts compared to rural areas in LMICs (Rodriguez et al., 2019).

Oman is situated in the Middle East at the northern edge of the Arabian Gulf and has a population of about 4 million (Al-Busaidi & Soriano, 2011). There is a marked shortage of statistics about asthma prevalence and asthma burden in Oman. The initial childhood asthma prevalence data available came from the ISAAC study, in which Oman participated during Phase 1 and Phase 3 (Asher et al., 1995). The ISAAC data from Phase 1 indicated that 10.5%

of Omani children ages 6−7 and 20.75% of children ages 13−14 reported asthma diagnoses (AL-Riyami et al., 2003). It is important to note that the ISAAC study was conducted over 20 years ago, and more recent data on the prevalence of asthma in Oman is available from the Global Asthma Report 2018. According to the report, the prevalence of asthma in Oman is 11.5% among school-age children (aged 6-7 years; (Global Asthma Network, 2018). In general, asthma prevalence is higher in older children in most of the Middle Eastern countries involved in the ISAAC study. Among the seven Eastern Mediterranean countries that participated in the ISAAC programme, Oman exhibited the highest prevalence of asthma in children, although it was in the intermediate range of the ISAAC global ranking. Additionally, Oman was among the top countries in the ISAAC global ranking of severe asthma symptoms, which included wheezing that awakens a child from sleep and limit their speech. Sleep-awakening wheezing in Oman was four times that of Iran and double that of Malta (AL-Riyami et al., 2003).

The Asthma Insights and Reality in the Gulf and the Near East (AIRGNE) study was conducted in five countries: Oman, the United Arab Emirates (UAE), Kuwait, Jordan and Lebanon. The study assessed asthma control and the quality of asthma management among individuals with asthma in these countries (Khadadah et al., 2009). In addition, the study aimed to evaluate how closely GINA guidelines were followed. In Oman, the study was conducted in the most populated urban governorates—Muscat, Sohar and Nizwa—and included 201 participants with asthma, 21% (n = 43) of whom were 5−15 years old. Of the children involved in the study, 84% (n = 36) had experienced sudden severe exacerbation in the previous 12 months, 60% (n = 26) recalled exercise-induced asthma in the previous 12 months and 60% (n = 26) reported night awakening due to asthma in the previous four weeks.

In the same study, the use of preventive ICSs was reported by only 5% of participants, reflecting one of the lowest ratios in the region. Participants relied on the use of quick-relief medication (92%) rather than preventive medication (ICSs). As a result, the study reported 52% of both adults and children visiting the ER and 23% of both adults and children hospitalised in the previous 12 months. These incidents led to some children (32.2%, n = 14) reporting asthma-related missed school days in the preceding year, with a mean number of 6.1 missed school days. Thirty-five per cent (n = 15) of children had a peak flow meter, and only 19% (n = 8) had

ever undergone a lung function test. The study concluded that GINA recommendations were largely unmet (Khadadah et al., 2009).

The unacceptably low use of preventive ICSs among children with asthma in Oman implies an immediate need to promote education and awareness for these children, their caregivers and healthcare professionals. GINA guidelines recommend treating airway inflammation as a priority when responding to symptoms. Most children with asthma have their disease under control if low doses of ICSs are regularly and correctly administered (Bush et al., 2017). One of the issues that emerged from the very low use of ICSs in the AIRGNE findings is the perceived level of asthma control among affected children, their caregivers and their healthcare providers. Underestimating asthma severity can impede effective management of this condition, predisposing children to worsening symptoms. This is evident in the study by Al Busaidi and Al Mukhainin (2009), who assessed the then-current level of asthma control by surveying clients visiting the chest clinic at the Royal Hospital, a tertiary hospital in Oman. The study used the Asthma Control Test on 141 participants ages 13−82, 100 of whom were females age 13 years and older (Al Busaidi & Al Mukhaini, 2009). Discrepancies were found between the clients' perceptions of asthma control and the objective assessment of asthma severity. The majority of clients (61%) overrated their level of control by describing their asthma as well or completely controlled; however, according to the Asthma Control Test, 54% had poor asthma control. Night-awakening symptoms were reported by 66% of participants and the use of rescue medications was reported by 70%. Half of the participants reported that asthma had an impact on their work or school attendance.

The results of the above studies are not children-specific. Nonetheless, they reflect the level of understanding of asthma control among people with asthma in Oman and their healthcare providers, who might be complacent about the level of control of this condition.

2.7 Asthma Cost Among Children in Oman

At present, there are no governmental data documenting asthma costs. Al-Busaidi et al. (2013) conducted a study that addressed both the prevalence and cost of asthma in Oman. The researchers used the revised Delphi method to collect data from a panel consisting of 10 expert

physicians in asthma management. This method was preferred over a face-to-face group panel to ensure that information was obtained from each member without the influence of other group members. The study reported that the prevalence of asthma in Oman was estimated to be 7.3% in adults (n = 96,470) and 12.7% in children (n = 58,344). Ninety-five per cent of children age 5−15 (n = 55,426) used governmental healthcare services (Al-Busaidi et al., 2013). The study found that hospital admissions and ER visits accounted for the majority of asthma costs among children in Oman; that is, 42% (n = 23,279 children) for hospitalisations and 55% (n = 30,485 children) for ER use per year. The largest portion of the total direct cost for asthma treatment came from hospitalisation. The total number of nights that asthmatic children in Oman spent in hospitals per year was estimated to be 217,892. Additionally, children with asthma made a total of 192,052 ER visits and 139,176 outpatient visits per year. Outpatient visits and medication costs accounted for only 20% of the total costs (Al-Busaidi et al., 2013). The same study reported that the total annual cost of asthma treatment, excluding medication, was found to be US $10,441,195 for children ages 5−15. As ER visits and hospital admissions accounted for the majority of the total costs, the researchers concluded that poor asthma management and control placed the heaviest burden on the country's healthcare system (Al-Busaidi et al., 2015).

2.8 Cultural Practice Triggering Asthma

A widespread practice in Oman and other Arabian Gulf countries is the burning of Arabian incense (*bakoor*), which is one of the most common sources of indoor smoke in the region (Al-Rawas et al., 2009; Dalibalta et al., 2018). A wide variety of substances are used to produce *bakoor*, including woodchips from agarwood (*oud*), flowers, musk and sandalwood, along with scented oils and perfumes that undergo a slow burning process (Dalibalta et al., 2018). *Bakoor* is usually burned using wood charcoal, which releases toxic chemical particles associated with respiratory symptoms (Al-Rawas et al., 2009).

A study was conducted in Oman using the ISAAC questionnaire with a few additional questions about the use of Arabian incense (Al-Rawas et al., 2009). The research included a total of 2,442 children (mean age 10.8), 15.4% of whom had current asthma. The study evaluated the relationship between the frequency of *bakoor* use and asthma symptoms. After controlling for potential confounding factors, the study found that parents who reported using *bakoor* more

than twice a week were more likely to report that their child's breathing was affected by it compared to parents who rarely used *bakoor*. This effect was 2.5 times higher in children with asthma. *Bakoor* was found to cause a worsening of wheezing in 38% of children with asthma, placing it as the fourth most common trigger after dust (49.2%), weather (47.4%) and respiratory tract infection (42.2%). Despite this, no significant link was recorded between *bakoor* use and the prevalence of current asthma.

In comparison to other AIRGNE study countries, the level of asthma management was suboptimal in Oman, as demonstrated by the very high use of rescue medications, low number of prescriptions for ICSs and high frequency of asthma-related visits to the ER (Al-Busaidi & Soriano, 2011; Al-Busaidi et al., 2015). Since Oman has a high asthma prevalence among children, managing asthma as a chronic condition among children has become a priority. Nevertheless, the small number of asthma studies conducted with children in Oman focused mainly on asthma prevalence (Al Riyami, 2018). As asthma morbidity is highly preventable, promoting education for all clients with asthma and their families is an effective way to improve asthma management in Oman.

2.9 The Nursing Profession in Oman

Before 1970, Oman's healthcare system was poor and resulted in a high mortality rate, particularly among infants and children (Hill & Chen, 1996). In 1970, a royal decree was issued to establish the Ministry of Health, which was charged with providing high-quality health care by establishing modern hospitals and health centres across the country. In the years that followed, modernisation was brought into all aspects of health care ("Professional nursing in Oman," 2013).

In 1979, the Directorate of Nursing was founded at the MOH, which helped recognise that nurses in Oman had become a cornerstone of the healthcare system ("Professional nursing in Oman," 2013). As in many other countries, foreign-educated workers helped establish the nursing profession in Oman, and efforts were made to engage Omanis to become nurses. Nursing education began with a two-year vocational training programme in 1970 that was expanded to 3.5-year training in 1973, with only 83 Omanis graduating as assistant nurses.

Between 1982 and 1990, the MOH launched a second programme, from which 156 assistant nurses graduated. These nurses were required to provide fundamental bedside nursing care and also facilitated medication administration (Al Maqbali et al., 2019). It was not until 1991 that the establishment of nursing education institutes began to produce competent nurses through a three-year diploma programme. This was followed by the establishment of the Oman Specialised Nursing Institute in 2001, which offered a bachelor-level nursing bridge programme (Directorate General for Planning Affairs, 2014).

Over the past 20 years, nursing has become one of the fastest-growing professions in Oman. The nurse-to-population ratio increased from 5.6 nurses per 10,000 population in 1975 to 44.8 nurses per 10,000 in 2016 (Al Maqbali et al., 2019). However, the country struggled with a shortage of well-trained nurses to meet the population demand ("Professional nursing in Oman," 2013). Oman has witnessed remarkable socioeconomic development that also has led to the manifestation of chronic diseases. As a result, chronic disease management was one of the six identified leadership priorities defined by the country in collaboration with the WHO (WHO, 2017b).

2.10 School Nursing in Oman

School nursing in Oman is a growing field that was developed in response to service need changes (Al Maqbali et al., 2019). As the number of schools increased to accommodate the growing younger population, the need for well-established school nursing programmes has become a priority. However, there is no Omani national profile on the education of school nurses. In Oman, school nurses are registered nurses who hold either a diploma or a bachelor-level nursing qualification who have worked in primary health care and then moved to school nursing. Nevertheless, they may not be academically prepared to be a school nurse. Certain tasks have been identified by the MOH for school nurses but not as part of a formal scope of practice. Moreover, no licence is required to work as a school nurse. School nurses are required to attend continuing education sessions, but the extent to which these sessions fulfil their educational needs requires further exploration.

Data on the workforce profile of school nurses in Oman are required to build a body of research on their role in the management of chronic conditions, particularly asthma, in the school setting. A national profile of school nurses would reflect the quality of care provided to students.

Currently, a school nurse is available two days per week in most governmental schools. The role of school nurses in Oman is focused on admission screening of grade one children, vaccine administration, health education and day-to-day first aid administration. Given the impact that asthma has on schoolchildren, school nurses must engage effectively in the management of these children and have continuous access to asthma education programmes. School nurses with the necessary knowledge are able to effectively manage asthma in children, potentially resulting in a reduction in ER visits and hospitalisations, thus enhancing children's quality of life as well as improving control of their disease (Kawafha & Tawalbeh, 2015). However, the number of school nurses in Oman continues to decline. To support this workforce and their significant contribution to community health, the role of school nurses must be clearly defined.

2.11 Conclusion

Asthma is a chronic disease with highly preventable morbidity. It starts in early childhood and differs in severity during a person's lifetime. International asthma prevalence data among children were obtained from the ISAAC study, which was conducted 19 years ago. To establish up-to-date figures on the global prevalence of childhood asthma and to compare the numbers between countries, there is a need for a large-scale worldwide survey using standardised tools.

Various factors have an impact on children's asthma prevalence and severity, such as indoor and outdoor environments, smoke exposure and air pollution. To prevent asthma and reduce its morbidity, both pharmacological treatments and non-pharmacological primary care interventions are needed. Such interventions include self-management education and personalised action plans.

In Oman, asthma prevalence data came from the ISAAC study published for two age groups: 6−7 years old and 13−14 years old. In addition, AIRGNE and national studies provided data about asthma prevalence and level of control in children. However, studies of asthma in Oman are scarce. The last study was conducted in 2015 and concluded that the asthma management

level in the country was suboptimal. The evidence from these studies indicates that, whereas asthma education has been studied in different cultural contexts, the issue remains fundamentally underexplored in Oman. School nurses can significantly contribute to reducing the asthma burden in Oman. Unfortunately, despite the solid foundations of the school nursing field, no single study has explored school nurses' role in chronic disease management among schoolchildren. The lack of a national profile of school nurses in Oman also needs to be explored. Such a profile can reflect current school nursing practices and help these professionals consider what practices should be changed or amended. Additionally, a school nursing profile would help to develop an information base of the current state of school nurses' knowledge, roles, function and training needs in relation to asthma management. Such an undertaking would open new vistas for the management of other chronic conditions. Establishing a national profile of school nurses can, therefore, target educational efforts to reduce the disease burden.

Since Oman has a high asthma prevalence among children, managing asthma as a chronic condition among children has become a priority. With the absence of a national profile for school nurses in Oman, their role in asthma management is ambiguous.

Critical Analysis of the Literature

Chapter 3: Impact of School Nurse-Led Asthma Interventions on Child's Health Outcomes.

3.1 Introduction

As outlined in Chapter 2 (Section 2.5), school nurses play a prominent role in asthma management in school settings. Given the leading role these nurses occupy within the school setting, they are often the best suited health care professionals to lead asthma programmes. However, most school-based asthma programmes have been conducted by researchers outside the school setting. This chapter presents a scoping review that explores school nurse-led asthma intervention programmes and their impact on children's asthma-related health outcomes. The following scoping review was published in the Journal of School Nursing in 2022 (Kindi et al., 2022).

3.2 Scoping Review Objectives

The objective of this scoping review is to examine and map out what is currently known about the impact of school nurse-led asthma intervention programmes on children's health outcomes. The review included only those school-based programmes that were led by school nurses. The review objectives were to:

1- Describe the types of school nurse-led asthma intervention programmes that have been reported for the school-aged population, their impact on children's asthma-related outcomes, and the role of school nurses in each programme.
2- Identify the research gaps in the existing literature concerning aspects of school nurse-led asthma intervention programmes, particularly educational interventions.

3.3 Scoping Review Methods

True to their name, scoping reviews are an ideal tool to scope the field of interest and give an indication of available studies and their focus (Munn et al., 2018). Scoping reviews tend to address topics from a broader perspective where various study designs can be included. They

aim to identify the existing evidence and the methodology used. Furthermore, they aim to identify research gaps in existing literature (Arksey & O'Malley, 2005). As I aim to identify gaps in the literature and examine how the research was conducted, a scoping review methodology was used to map the evidence and identify the studies' characteristics regarding the impact of school nurse-led asthma education programmes on child health outcomes. Arskey and O'Malley, described a framework for scoping reviews and suggest that scoping reviews could be a considered as a method of their own, leading to dissemination of research findings through publication without the need for a full subsequent systematic review (Arksey & O'Malley, 2005). Their methodological framework for conducting scoping reviews is guided by a requirement to identify all relevant literature regardless of study design to ensure the literature is covered in a comprehensive way. Arkey and O'Malley (2005) adopted five stages for conducting a scoping review: Stage 1: identifying the research question, Stage 2: identifying relevant studies, Stage 3: study selection Stage 4: charting the data, Stage 5: collating, summarizing and reporting the results.

Compared to systematic reviews, scoping reviews do not produced critically appraised and synthesised results, as quality assessments are not a requirement for this form of review (Arksey & O'Malley, 2005; Munn et al., 2018) Compared to traditional literature reviews, scoping reviews are systematic and include a rigorous, transparent systematic literature search with steps designed to reduce errors, increase reliability and extract and present data in a structured way (Peters et al., 2015).

3.3.1 Inclusion/Exclusion Criteria

The population, exposure, and outcomes framework was employed to guide the selection of included studies and can be seen in Table 3.1 (Bettany-Saltikov, 2012). As scoping review ensures the collection of comprehensive evidence. The search was not limited by study type; however, included studies must have interventions led by a school nurse.

Table 3.1. *PEO Framework.*

Step	Description
Population	School-aged children aged five to 18 years old, their parents, school staff, nurses of any type and other health care professionals.
Exposure	School nurse-led asthma interventions, defined as any type of asthma programme (educational or non-educational) directed, provided or administered by school nurses to enhance asthma management outcomes among students, parents and the community that was conducted in a school setting.
Outcome	Asthma management outcomes including knowledge and skills needed for asthma management, thereby reducing health care utilization (emergency room visits, hospitalization) and missed school/workdays. Children's health outcomes were broadly defined to include medication use, asthma severity, symptom frequency, number of exacerbations, activity limitations, and quality of life.

Note. Exclusion criteria: Studies with asthma interventions that were not school nurse-led and studies outside the school setting were excluded. Case management and infection prevention studies were also excluded.
PEO = population, exposure and outcomes; ER = emergency room.

3.3.2 Search Strategy

Six electronic databases were searched: Cumulative Index of Nursing and Allied Health Literature (CINAHL), PsychINFO, MEDLINE, Educational Resources Information Centre (ERIC), EMBASE, and Applied Social Sciences Index and Abstracts (ASSIA). The search was limited to articles published in the English language and was not limited to a specific time period. The reference lists of the retrieved articles were examined but the manual search did not uncover additional eligible studies. The search was carried out between June 2020 and August 2020. Search terms related to “asthma,” “school” and “nurses” were adapted to maximise results from each database. These terms were combined with the Boolean operator (AND). The search strategy was designed in the CINAHL database and translated to other databases (Table 3.2).

Table 3.2. Search Strategy Index Terms Used in Databases.

	Concept	Index Term: CINAHL	Index Term: Medline (EPSCO)	Index Term: PsycINFO	Index Term: EMBASE
#1	**Asthma**	(MH "Asthma+")	(MH "Asthma+")	No index term	'asthma'/exp
#2	**Nurse**	(MH "Nurses+")	(MH "Nurses+")	No index term	'nurse'/exp OR 'nursing staff'/exp
#3	**School**	(MH "Schools+")	(MH "Schools+")	No index term	'school'/exp

Concept	**Index term**	**Keywords**	**Combined with OR**
Asthma	(MH "Asthma+")	asthma*	(MH "Asthma+") OR TI (asthma*) OR AB (asthma*)
School	(MH "Schools+")	school* OR college* OR high school OR high-school OR pre-school OR pre-school OR institute* OR junior school OR junior-school	(MH "Schools+") OR TI (school* OR college* OR high school OR high school OR preschool OR pre-school OR institute* OR junior school OR junior-school) OR AB (school* OR college* OR high school OR high-school OR preschool OR pre-school OR institute* OR junior school OR junior-school)
Nurse	(MH "Nurses+")	Nurse* OR nursing*	(MH" Nurses+") OR TI (nurse* OR nursing*) OR AB (nurse* OR nursing*)

3.3.3 Study Selection and Data Extraction Process

The literature review search was conducted in consultation with the university librarian. Figure 3.1, PRISMA flow diagram, shows the process of study selection according to the Preferred Reporting Items for Systematic Review and Meta-Analyses guidelines (https://www.prisma-statement.org/). As shown, the initial database search resulted in 2,117 papers that were exported to Endnote reference manager. In Endnote, 647 duplicates were removed, leaving 1,470 papers to be screened. These were then exported into Covidence online software. A three-step process was followed to assess the inclusion/exclusion of articles. In the first step, screening of title and abstracts was performed using Covidence software extraction 2.0 (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia). Following the

review of titles and abstracts, 19 papers went forward for full-text review. In the second step, I and one of my supervisors independently reviewed the full text of the 19 articles to determine alignment with the inclusion criteria. Of these, 12 studies were excluded because they focused on school nurse case management (N = 5) or were not a school nurse-led intervention (N = 7). Overall, seven studies were included in the review. There were no disagreements between the evaluators when selecting and extracting the data. The third step involved reviewing the bibliography of the identified articles; no additional articles were identified.

Data from the included studies were extracted into an evidence table that included author, year, country, aim, design, population/sample, nature of the intervention, outcome assessed, results and measurement tools (Table 3.3).

Figure 1

PRISMA flow chart

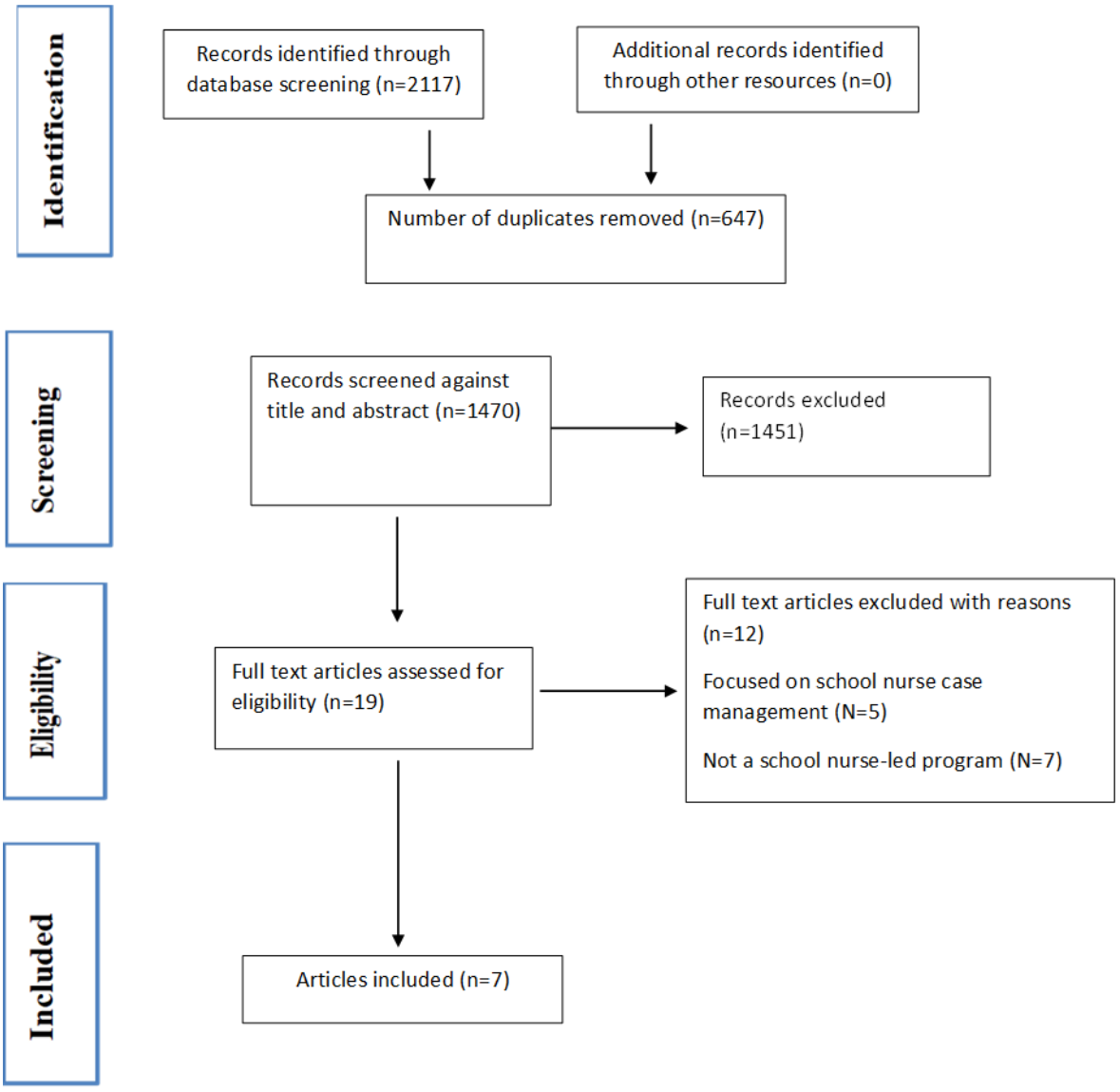

Figure 0.1. PRISMA flow chart

Table 3.3.Characteristics of the Included Studies

#	Citation Country	Objective	Design	Population Sample	Nature of intervention	Tools	Outcomes Results
1	(Persaud et al., 1996) United States	To examine the effectiveness of an asthma education programme on children and their parents.	RCT ‖ Level I≠	36 children with asthma (8–12 years old, mean age 10.2 SD§ = 1.5 randomly assigned intervention group (18) Control group (18)	SN* attended two 4-hour in-service sessions to improve asthma management knowledge and skills. After the training, SN delivered a 20-minute individual training session to children over eight weeks. Children were divided into an intervention group and a control group. The intervention group received teaching sessions and the child's weekly progress was recorded on a checklist. The control group received regular care but no asthma education.	Five standard questionnaires: Children's asthma knowledge: 20 items Parent's asthma knowledge: 55 items Child's asthma attitude: 28 items Child health locus of control: 20 items Functional status: 28 items.	Children's asthma knowledge (p = .9) health locus of control (p = .17) attitudes toward asthma (p = .3); functional status (p = .8); school absenteeism (6.4 days vs.7.6 days); and ER visits (p < .05) Parent's asthma knowledge (p = .54).

Note. ‖ Randomised Control Trial, SN* = school nurse; NA** = not applicable; ER# = emergency room, SD§ = Standard Deviation, ≠ a Refer to level of evidence in Table 3.5

#	Citation Country	Objective	Design	Population Sample	Nature of intervention	Tools	Outcomes Results
2	(Salisbury et al., 2002) United Kingdom	To compare a nurse-led clinic in schools versus care in general practice for adolescents with asthma.	RCT‖ Four schools, Parallel observation study in two schools Level I≠	N=490 adolescents with asthma, mean age 13 SD:NA Age range: NA** Intervention (156) Control (149)	Adolescents with asthma were individually randomised to receive a review of their asthma status at school (school clinic group n= 156) or in general practice (practice care group n= 149). A parallel observational comparison between adolescents in the practice care group of the randomised trial and pupils in two control schools (control school group) was performed.	Paediatric quality of life questionnaire Asthma knowledge and attitude quiz.	Primary: Attendance for an asthma review (p < .001) Symptom control (p = .42) Quality of life (p = .63). Secondary: Knowledge (p = .001) and attitude (p = .007); Inhaler technique (p < .001); use of steroids (p = .60); school absence (p = .78); PFM (p = .36).

Note. ‖ Randomised Control Trial, SN* = school nurse; NA** = not applicable; ER# = emergency room, SD = Standard Deviation, ≠ a Refer to level of evidence in Table 3.5

#	Citation Country	Objective	Design	Population Sample	Nature of intervention	Tools	Outcomes Results
3	(Carpenter et al., 2016) USA	To test whether a tailored inhaler technique video intervention: (1) could befeasibly implemented by school nurses and (2) improve the inhaler technique of children with asthma. Duration: 1 month Theory: No	Quasi-experimental design Level III≠	N=25 children with asthma (age 7–17, mean SD§ 2.4)	SNs were trained on the MDI technique using a validated training process. Then, SNs* measured children's inhaler technique before and after watching tailored inhaler technique videos. Immediate feedback was given to the child and a record of child performance was shown. One month later, reassessment was done	Validated checklist	Inhaler technique Significant improvement with spacer (p = .03), without spacer (p = .01)
4	(Harrington et al., 2018) USA	To investigate whether high adherence to ICS asthma preventive treatment among students with persistent asthma was achievable through school nurse-supervised asthma therapy. Duration: 60 Days Theory: No	Pilot, prospective, RCT Level I≠	N=45 children with asthma in elementary and middle school (5-12 years old, mean age = 8). Intervention group=21 Control group=25.	Therapy was directly observed by SNs* every day that school was in session and by parents every evening on school days, every morning and evening on weekends and on all holidays.		The total proportion of ICS morning doses (p = .11). School absence (p = .17). Health care utilization: ER visits (p = .71), hospitalization (p = .29) QoL: Family adjustment (p = .03), Less functional limitation (p = .04).

Note. RCT ||= Randomised Control Trial SN* = school nurse; NA** = not applicable; ER# = emergency room, SD§ = Standard Deviation, ≠ a Refer to level of evidence in Table 3.5

#	Citation Country	Objective	Design	Population Sample	Nature of intervention	Tools	Outcomes Results
5	(Trivedi et al., 2018) USA	To examine the impact of a novel, school nurse-supervised asthma therapy programme on healthcare utilization. Duration: 24 months Theory: No	Quasi-experimental, time series design	N = 62 children with asthma from 44 schools (age range: NA, mean age 10.5 (SD§ = 3.7)	SN* direct observation of daily preventive asthma medication	School records	ER visits ($p < .001$), hospital admissions ($p < .001$), school absences ($p = .28$) and rescue medication use ($p < .001$).
6	(Simoneau et al., 2020) USA	To evaluate the effectiveness of a five-element school nurse-led asthma management programme in providing asthma care and reducing school absenteeism.	Quasi-experimental Level III≠	15 school nurses N=251 students with asthma from elementary schools (age range (6-12), mean age 8.7 (SD§ = 2.2)	Twenty-eight school nurses trained through an on-site, one-on-one 30 min session, provided with training manual and instruction on five elements (asthma risk assessment, control, education, medication and communication with the medical provider). Once trained, SNs* (n=15) implemented the programme in their schools based on a needs assessment of each student (two academic years). Ten SNs were surveyed about confidence in asthma management.	Retrospective review of school records.	School absence ($p < .001$), Inhaler technique ($p < .001$) School nurse satisfaction (92% were satisfied).

Note. || Randomised Control Trial SN* = school nurse; NA** = not applicable; ER# = emergency room, SD§ = Standard Deviation, ≠ a Refer to level of evidence in Table 3.5

#	Citation Country	Objective	Design	Population Sample	Nature of intervention	Tools	Outcomes Results
7	(Isik et al., 2020) USA	To examine the effectiveness of a theoretically based school nurse-led asthma intervention on asthma symptoms, self-management, peak flow meter usage, daily activities and school absences in children 7–12 years old. Theory: Orem's self-care theory	RCT ‖, repeated measures design Level I≠	N=37 asthmatic children (7-12 years old, mean age 9 (SD§ =1.67) from eight primary schools.	The treatment group received the asthma intervention composed of theoretically based school nurse-led asthma intervention, which comprised six weekly 30-min group lessons, PFM for personal use and hands-on experiences. The control group continued to receive usual care. Data collection points: At baseline, six weeks and 12 weeks.	Asthma Control Questionnaire (ACQ) Paediatric Asthma Quality of Life Questionnaire (PAQLQ)	Symptoms ($p < .001$), asthma control with a peak flow meter usage ($p < .001$), daily activities ($p < .001$). School absence ($p = .17$).

Note. ‖ Randomised Control Trial, SN* = school nurse; NA** = not applicable; ER# = emergency room, SD§ = Standard Deviation, ≠ a Refer to level of evidence in Table 3.5

3.4 Results

The purpose of this review was to identify the current evidence regarding the impact of school nurse-led asthma intervention programmes. The school nurse's role in the included studies varied between providing educational interventions for asthmatic children (Persaud et al., 1996; Carpenter et al., 2016; Isik et al., 2020; Simoneau et al., 2020), supervising the administration of preventive asthma medication (Harrington et al., 2018; Trivedi et al., 2018) and running a school asthma clinic (Salisbury et al., 2002).

3.4.1 Study Characteristics

All included studies (N = 7) discussed an asthma programme led by a school nurse (Persaud et al., 1996; Salisbury et al., 2002; Carpenter et al., 2016; Harrington et al., 2018; Trivedi et al., 2018; Simoneau et al., 2020). Furthermore, all reported at least one asthma-related health outcome. The seven studies combined represented a total of 946 school-aged children and 15 school nurses. The sample size ranged from 25 to 490. The target population of the included studies was children alone (Carpenter et al., 2016; Harrington et al., 2018; Isik et al., 2020; Salisbury et al., 2002; Trivedi et al., 2018), children with their parents (Persaud et al., 1996), or children and school nurses (Simoneau et al., 2020). Notably, none of the studies included in this review indicated the qualification of the school nurses who led the interventions.

The intervention programmes led by school nurses were conducted in the school setting. Six studies were conducted in the United States and one in the United Kingdom (Salisbury et al., 2002). The research study designs used in the included studies were randomised controlled trials (RCTs; N = 4; Harrington et al., 2018; Isik et al., 2020; Persaud et al., 1996; Salisbury et al., 2002) or quasi-experimental designs (N = 3; Carpenter et al., 2016; Simoneau et al., 2020; Trivedi et al., 2018). Table 3.5 shows the evidence level (Melnyk & Fineout-Overholt, 2015) assigned to the studies based on the methodological quality of their design. This evidence table is a hierarchal evidence of classifying studies according to the strength of the design, with Level I being the strongest research evidence.

Table 3.4. Melnyk Levels of Evidence

Level 1 - Systematic review & meta-analysis of randomised controlled trials; clinical guidelines based on systematic reviews or meta-analyses
Level 2 - One or more randomised controlled trials
Level 3 - Controlled trial (no randomization)
Level 4 - Case-control or cohort study
Level 5 - Systematic review of descriptive & qualitative studies
Level 6 - Single descriptive or qualitative study
Level 7 - Expert opinion

The aim of this review was to examine the impact of school nurse-led asthma intervention programmes on child health outcomes. The review identified that school-nurse led asthma intervention included educational intervention (four studies), school nurse supervised asthma therapy (two studies) and school nurse asthma clinics (one study). The seven included studies reported on child health outcomes. As such, the discussion of studies in this review is grouped into the following categories: (1) school nurse asthma education intervention, (2) school nurse supervised asthma therapy, (3) school nurse asthma clinics, and (4) asthma-related health.

3.4.2 School Nurse Asthma Education Intervention

Four studies evaluated school nurse-led asthma education programmes, with two being RCTs (Isik et al., 2020; Persaud et al., 1996) and two being quasi-experimental studies (Carpenter et al., 2016; Simoneau et al., 2020). The format of the education programmes varied to include structured educational sessions (Isik et al., 2020; Persaud et al., 1996; Simoneau et al., 2020) and a tailored video programme (Carpenter et al., 2016). The asthma education sessions led by school nurses were delivered to a group of participants in a face-to-face setting (group format) in two of the studies (Carpenter et al., 2016; Isik et al., 2020; Simoneau et al., 2020) and in a one-on-one session (individual format) in the other two studies (Persaud et al., 1996; Simoneau et al., 2020).

The participating school nurses in Persaud et al.'s (1996) study attended a 4-hr training session to improve their knowledge and skills before they delivered the education session to children. They received a theoretical session covering asthma pathophysiology, management strategy and medication use and received a practical demonstration on peak flow monitoring, inhaled medication, and the use of spacer devices. They were also introduced to the following educational strategies: communicating with children, conducting interviews and role-plays and providing positive reinforcement. Following the 4-hr training session, the nurses provided a weekly one-on-one, 20-min session to each child for eight weeks. Children were taught asthma self-management principles and peak flow monitoring. Before the education sessions and following the consent process, children were randomly assigned to the intervention group (N = 18) and the control group (N = 18). Both groups had a preintervention appointment where they received a physical examination and pulmonary function test by a paediatrician. However, the intervention group received education sessions by the school nurse, while the control group received no education. There were two data collection points: at baseline and immediately following the eight-week session.

Similarly, Carpenter et al. (2016) provided a validated training programme to school nurses before the nurses delivered the education sessions to the children. However, Carpenter et al.'s (2016) study focused on the inhaler technique. School nurses watched a demonstration video on inhaler use by three children. Then, they viewed 18 incorrect inhaler techniques and used a certified respiratory therapist checklist to score each technique. Thereafter, they received feedback on each video. After the training, the nurses recruited a convenience sample of seven asthmatic children (four elementary, two middle school, and one high school). The children demonstrated their inhaler technique and the nurses evaluated the demonstration using a checklist score. The children's demonstrations were videorecorded and entered into a tailored video software programme. The children then viewed a correct inhaler technique by one of the video characters of their choice (there were six characters with different genders and ethnicities). The children then watched their 1–2-min tailored video with systematic feedback on each step demonstrated. In addition, the children were praised for each correct step with positive statements. One month later, school nurses asked the children to demonstrate the

inhaler technique and evaluated them by using the same validated checklist to score their technique. This was the only follow-up point after the intervention.

Simoneau and colleagues (2020) investigated the effectiveness of a five-element school nurse-led asthma management programme for providing asthma care and reducing school absenteeism. In this study, the school nurse-led asthma intervention extended beyond a structured education programme. Researchers trained 28 school nurses on five programme elements (asthma risk assessment, control, education, medication and communication) with the medical care provider. Once trained, the nurses conducted the five-element programme in their school setting. They continued to enrol students throughout the two academic years (2015–2016 to 2016–2017). An area of concern in this study was that school nurses could choose elements to deliver based on a needs assessment of each student with asthma. This led to limited implementation of specific elements of the programme, such as communication with primary care providers, where school nurses communicate concerns or pose questions to the child's primary care provider. The most utilised element was the inhaler technique task. There were 102 students with asthma who completed two inhaler technique assessments over the two academic years: one at baseline and one at the end of the academic year.

Isik et al. (2020) investigated the effectiveness of a theoretically based school nurse-led asthma intervention that was focused on symptoms, asthma self-management with peak flow meter (PFM) usage, daily activities and school absenteeism among elementary school children aged 7–12 years. Participants were randomly assigned to a school nurse-led asthma intervention (treatment N = 37) or usual care (control N = 36). The intervention group received a school nurse-led asthma educational session over six weeks. The topics covered were: (1) pathophysiology, (2) PFM, (3) symptom identification and asthma action plans, (4) medication and delivery devices, (5) trigger identification and prevention as well as breathing exercises and (6) individualised discussion and self-management strategies. To improve class interaction, the researchers utilised hands-on practice, problem-based learning, case studies, storytelling, role-play and class discussions. The treatment group received a PFM with a personal peak flowchart and a spacer. The control group received usual care, which refers to receiving their medication according to the action plan prescribed by the child's doctor. Data collection took place three times: at baseline, after six weeks and after 12 weeks.

3.4.3 School Nurse-Supervised Asthma Therapy

Two studies examined school nurse-supervised asthma therapy (Harrington et al., 2018; Trivedi et al., 2018). An RCT conducted by Harrington et al. (2018) assessed school nurses' administration of asthma therapy to students with persistent asthma (N = 21) and its impact on asthma-related health outcomes. The nurses administered a daily dose of the inhaled corticosteroids (ICS) every morning at school to those assigned to the intervention group (n = 18), while the caregivers administered the ICS at home every evening of the school week and every morning and evening during holidays. For the control group (n = 25), the ICS doses were prescribed to be administered daily by the caregivers at home every morning and evening for the two-month study period. There were two data collection points: at baseline and 60 days after enrolment. Structured telephone follow-up interviews were conducted with caregivers to assess ICS doses and parental-reported asthma symptoms and disability during the study period. Similarly, Trivedi et al. (2018) investigated the outcome of health care utilization after a school nurse-supervised asthma intervention that included daily directly observed ICS medication administration. The difference in this study is that the school nurse administered both the morning (at 8:00 a.m.) and evening doses (at 2:00 p.m.) at school. There were 84 enrolled children with asthma. As part of the programme, school nurses provided training to participants on the correct inhaler and spacer techniques, but there was no reporting on how often instructions were given or how often these skills were followed up on. The study included a retrospective assessment of asthma-related ER visits, asthma-related hospital admissions and school absenteeism one year before enrolment and one year after enrolment.

3.4.4 School Nurse Asthma Clinic

Salisbury et al. (2002) conducted an RCT of a nurse-run asthma clinic in four secondary schools. Asthmatic adolescents at these schools were randomly assigned to receive a review of their asthma status at school (school clinic group) or in general practice (GP; practice care group). The nurse-run asthma clinic took place weekly in each of the four schools. The school clinic group received the same care as the practice care group; however, the discussion was tailored to the needs and interests of adolescents. Follow-up was done at the school asthma clinic one month and six months after the initial assessment. Students in the control group were invited by

their practice to attend an asthma review that could be provided by a practice nurse or a doctor, according to the usual practice.

3.4.5 Asthma-Related Health Outcomes

The focus of this scoping review is to discuss the available evidence in relation to the impact of school nurse-led asthma programmes on children's health-related outcomes. The measurement of different outcomes varied and was complex due to the incomplete data reported by some studies. The outcomes reported included: medication use, inhaler technique, PFM use, symptoms, school absence, quality of life, health care utilisation and asthma knowledge.

3.4.5.1 Medication use

Three studies evaluated medication usage among asthmatics in a school setting after a school nurse-led asthma programme (Harrington et al., 2018; Salisbury et al., 2002; Trivedi et al., 2018). Trivedi et al. (2018) found a significant decline in the number of asthma rescue medication (beta agonist) refills between the pre-and postintervention periods ($p < .001$). Harrington et al. (2018) reported no significant differences between the intervention and control groups in the number of children who reported use of ICS in the last two days ($p = 0.59$). However, the intervention group received 91.7% of the expected morning dose of ICS at school by the school nurse (which is more than the hypothesized percentage of 80%). Contrastingly, Salisbury et al. (2002) reported no significant differences in the number of adolescents prescribed ICS ($p = .89$) or daily ICS use ($p = .60$) following the implementation of a school nurse-led asthma programme.

3.4.5.2 Inhaler technique and PFM use

Two studies assessed the inhaler technique among students with asthma (Carpenter et al., 2016; Salisbury et al., 2002). Carpenter et al. (2016) evaluated a school nurse-led tailored video intervention to improve inhaler techniques among asthmatic children. The number of correct steps increased significantly from baseline after watching the video ($p = .03$). Carpenter and colleagues reported that the steps children most commonly missed were exhaling normally before taking a deep breath, shaking their inhaler four to six times and holding their breath for

10s after inhaling the medicine. In this study, children significantly ($p < .01$) sustained the inhaler technique at the one-month follow-up. Likewise, adolescents with asthma in the intervention group demonstrated higher inhaler scores ($p < .001$) than their peers randomised to the control group in the study by Salisbury et al. (2002).

There was a lack of PFM assessment in the included studies, with only two studies highlighting this outcome (Persaud et al., 1996; Salisbury et al., 2002). Persaud et al. (1996) did not assess changes in PFM reading; however, they reported that knowing the baseline PFM reading facilitated decision-making by school nurses on when to seek medical help or when to advise the child to use an inhaler. Salisbury et al. (2002) assessed PFM readings before and after the intervention, reporting no differences in PFM reading between the groups ($p = .36$).

3.4.5.3 Symptoms

Two studies assessed the impact of school nurse-led asthma programmes on symptom frequency (Isik et al., 2020; Salisbury et al., 2002). While Salisbury et al. (2002) reported no differences in the level of symptoms ($p = .42$) for the intervention group compared to the control group, Isik et al. (2020) reported a statically significant difference in asthma symptoms in the treatment group ($p < .001$) compared to the control group after a theoretically based school nurse-led asthma intervention ($p < .001$). Symptoms included cough, feeling fatigued, asthma exacerbation, wheezing, chest tightness, shortness of breath, night awakening, difficulty breathing and trouble sleeping at night (Isik et al., 2020).

3.4.5.4 School absence

The outcome of school absenteeism was measured using school records or self-reported data in six of the included studies (Harrington et al., 2018; Isik et al., 2020; Persaud et al., 1996; Salisbury et al., 2002; Simoneau et al., 2020; Trivedi et al., 2018). Overall, these studies reported a reduction in the number of missed school days among school-aged children after the school nurse-led intervention. Persaud et al. (1996) reported that five months after an asthma education programme delivered by school nurses, there was a decline in the number of missed school days in both groups, but there was no significant difference between the intervention and the control group (6.4 and 7.6 days, respectively). The same result was supported by Salisbury

et al. (2002) and Trivedi et al. (2018), who also reported a nonsignificant decline in asthma-related school absence between students in the treatment and control group.

Simoneau et al. (2020) reported that students with asthma who engaged in a school nurse-led asthma programme (easy breathing for schools) had a 25% reduction in their absenteeism rate compared to students without asthma who did not engage ($p < .01$). This translated into three to four gained school days annually. Similarly, Isik et al. (2020) reported that school absence decline was not significantly different between groups ($p = .179$), yet the treatment group missed fewer school days.

3.4.5.5 Quality of life

In this review, three studies examined quality of life as an outcome (Harrington et al., 2018; Persaud et al., 1996; Salisbury et al., 2002). Salisbury et al. (2002) assessed the differences in quality of life among asthmatic adolescents assigned to school clinics or GP care and found no significant difference in the quality-of-life score between the groups ($p = .63$).

Persaud et al. (1996) assessed child health locus of control using an instrument that measured children's perceptions of the extent to which their health was primarily affected by their actions versus outside forces. This study also assessed children's feelings about themselves using an asthma attitude survey. While differences existed between the intervention and control group, these were not significant and would require a larger sample to approach significance.

Harrington et al. (2018) assessed multiple measures of quality of life in terms of functional limitation, family adjustment, and medical interference. Significantly less functional limitations ($p = .04$), adjustments to family life ($p = .03$) and sleep loss due to asthma ($p = .04$) were reported after the school nurse-supervised asthma therapy. Overall, there was a statistically significant difference in quality of life in the treatment group compared to the control group ($p < .001$).

3.4.5.6 Health care utilisation

The impact of school nurse-led asthma programmes on health care use includes emergency room (ER) visits, unscheduled visits to physicians and/or hospitalisation. Out of the seven

included studies, three studies explored the impact of a nurse-led asthma programme on the number of ER visits (Harrington et al., 2018; Persaud et al., 1996; Trivedi et al., 2018). Persaud et al. (1996) reported that the percentage of students who attended the ER due to an exacerbation of their asthma was significantly higher in the control group (50%, n= 9) than in the intervention group (22% (n = 4, $p \leq .05$). However, when the age of onset was controlled, the association between the number of ER visits per child and the educational intervention was not statistically significant.

Trivedi et al. (2018) also found a significant reduction in asthma-related health care utilisation. The authors reported a decrease in asthma-related ER visits and asthma-related hospitalisation over a 1-year follow-up period after enrolment in school nurse supervised asthma therapy. ER visits declined 37.5% from the preintervention mean of 0.8 (SD = 1.2) to a postintervention mean of 0.3 (SD = .6) visits ($p < .001$). Asthma-related hospital admission showed a significant decline as well, from a preintervention mean of 0.3 admissions (SD = .6) to a postintervention mean of 0 admissions ($p < .001$). Contrastingly, Harrington et al. (2018) reported no difference in unscheduled ER visits or hospitalisations, as the school nurse-supervised asthma therapy was administered over 60 days.

3.4.5.7 Asthma knowledge among children and their parents

Only two studies in this review assessed the knowledge of children after an asthma programme was delivered by a school nurse (Persaud et al., 1996; Salisbury et al., 2002). Persaud et al. (1996) found that there was no statistically significant difference in the knowledge score among children ($p = .9$) and their parents ($p = .54$) after programme implementation. This was the only study that addressed parents' knowledge alongside that of their children. By contrast, Salisbury et al. (2002) found that asthmatic students attending school clinics (treatment group) had a greater knowledge of asthma compared to students in the practice care group (control group; $p = .001$).

3.5 Discussion

As has been illustrated, nurses play a leading role in the school setting, placing them in an optimal position to lead programmes in asthma management. This review aimed to determine

what is currently known about school nurse-led asthma intervention programmes and their impact on children's asthma-related outcomes by conducting a scoping review.

3.5.1 Types of School Nurse-Led Intervention Programmes and Their Outcomes

Our scoping review found that school nurse-led asthma programmes had a positive impact on children's asthma health related outcomes, which include medication use, reduction in school absenteeism, reduction in health care utilisation, improved asthma knowledge and quality of life. The review findings are consistent with previous non-nurse-led intervention studies, which found that school-based asthma programmes improved health outcomes and prevented complications (Rasberry et al., 2014; Horner et al., 2016; Suwannakeeree et al., 2016). However, not all of the interventions contributed to significant results. Indeed, there was a mix of statistically significant and nonsignificant findings. For example, only one study reported a significant reduction in asthma symptoms following the intervention (Isik et al., 2020), while another study found a significant difference in quality-of-life postintervention (Harrington et al., 2018).

The review highlighted a positive impact on medication adherence and, therefore, symptom frequency among children. This positive impact was not significant among adolescents in Salisbury et al.'s (2002) study. This could be due to adolescents' reluctance to go to the GP as recommended by the school nurse, who advised participants who needed drug changes or delivery devices to contact their GP. Persaud et al.'s (1996) findings revealed that younger children were more vulnerable to visiting the ER due to their asthmatic symptoms and are more likely to benefit from school nurse-led asthma programmes; thus indicating the significance of preventive health earlier in life. Ismaila et al. (2013), who systematically reviewed asthma burden in Canada (47 Studies, N = 1,350,871), emphasised this trend. They reported that rates of health care utilization outcomes (ER visits, hospitalisation and physician visits) are higher among children with asthma <18 years old. The frequency and accuracy of medication administration through medication delivery devices to either prevent symptoms or for quick episode relief are important indicators of asthma management. The review reported a weakening of inhaler technique skills as early as one month after receiving education on best practice inhaler techniques. This illustrates how improper inhaler technique is a major problem among

asthmatic children (Román et al., 2019). Suwannakeeree et al. (2016) echoed this point and noticed that the rate of ICS use among children with asthma at six months after the intervention was fewer than at three months after the intervention. Therefore, reinforcing the use of ICS through continuing education is necessary to maintain medication adherence. Continuing education about inhaler technique is a key factor in complying with ICS as preventive medication.

The research revealed poor inhaler technique among children (Gillette et al., 2016). While GINA guidelines recommended that inhaler technique should be assessed at every clinic visit to the primary health care professional, this is not properly conducted in practice (Cloutier et al., 2018). A systematic review extracted data from 55 studies involving 6,304 health care providers who performed 9,996 tests revealed that health care professionals lack knowledge regarding how to assess and teach inhaler techniques (Plaza et al., 2018). Only 15.5 % of health care providers performed inhaler technique correctly (95% CI, 12-19.3), declining over time from 20.5% (95% CI, 14.9-26.8) in the period from 1975-1995 to 10.8% (95% CI, 7.3-14.8) during the period from 1996-2014. As such, researchers have called for urgent training programmes aimed at providers.

School nurses are in the best position to conduct periodic skill assessments to prevent skill deterioration and promote the sustainability of learning. Because of their continuous presence in schools and ongoing connection with children and their caregivers, school nurses are best suited to provide education and monitor means of intervention sustainability. Whereas clinic visits may lack time for education and school-based interventions and terminate upon study completion, school nurses remain available to work with students in schools.

As seen in this scoping review, the studies varied regarding the number of follow-ups conducted. Persuad et al., 1996 collected data on a weekly basis over an eight-week period. The follow up was done during a scheduled clinic visit after the intervention. The exact timeframe was not specified. Salisbury et al. (2002), Carpenter et al. (2016), Harrington et al. (2018) and Trivedi et al. (2018) collected baseline data and performed follow-ups at six months, one month, two months and one year, respectively. While Simoneau et al. (2020) collected one-off baseline

data, data on school absence were collected for two academic years. Isik et al. (2020) collected data on three separate occasions (baseline, six weeks and 12 weeks).

As asthma is strongly linked to school absenteeism, studies supported school nurses' role in reducing school absence among students with chronic conditions (Moricca et al., 2013; Rodriguez et al., 2013; Johnson et al., 2019). The American Academy of Pediatrics Council recommended establishing a relationship with school nurses to improve chronic condition management (Council on School Health, 2016) because school nurses play a proactive role in preventing school absence among younger children with asthma. In line with this, my review stressed the essential role that school nurses play in preventing school absence among students with asthma. Despite reporting nonsignificant findings due to the small sample size, short assessment period and variation in absence recording, the five studies that investigated school absence reported a trend in the declining number of missed school days after the school nurse-led intervention, regardless of the intervention type.

Addressing asthma knowledge among children and their parents is an important determining factor of asthma management. The scoping review indicates that educating parents and children was a major component of school nurse-led asthma interventions. The National Heart, Lung and Blood Institute highlights the importance of involving children and their parents in asthma management (National Institutes of Health, 2012; van Bragt et al., 2015). However, in this review, only two studies examined asthma knowledge outcomes—one among children only and one among children and their parents. Despite being nonsignificant, the parent knowledge score showed an improvement (Persaud et al., 1996). Several school-based non-nurse-led asthma education programmes addressed asthma knowledge among children and their parents (Payrovee et al., 2014; Kintner et al., 2015; Grover et al., 2016; Horner et al., 2016; Suwannakeeree et al., 2016). These studies showed improved knowledge scores postintervention. Agusala et al. (2018) recommended involving parents in asthma programmes and indicated that parents reported increased knowledge in managing asthma symptoms and triggers. It is important to note that asthma knowledge can be improved through educational programmes; however, knowledge improvement does not necessarily reflect an improvement in care practice.

It could be argued from my review that ensuring the consistency and sustainability of the interventions is a challenge. Trivedi et al. (2018) reported that relying on the school infrastructure and the existing school nurse service promoted the sustainability and reproducibility of the intervention. However, it should be noted that school nursing services are not available across the globe. Such services require that asthma intervention programmes be developed for school personnel such as schoolteachers. A systematic review by Coelho et al. (2016; 17 studies N= 5,879) emphasised such a trend by highlighting that asthma educational activities should include the entire school community. Hence, students, teachers and school staff can avoid asthma triggers and be able to recognise symptoms earlier (Coelho et al., 2016). While schoolteachers play an essential role in implementing school policies, the literature showed that their asthma knowledge was suboptimal (Rodríguez et al., 2010; Lucas et al., 2012). To address such issues, some asthma education programmes were developed for teachers in the UK, the United States, Australia and Jordan (Kew et al., 2017). A Cochrane review included five studies that assessed the impact of asthma education programmes on the knowledge and attitudes of schoolteachers towards asthma management. They found that education programmes significantly improved the knowledge and self-reported confidence of schoolteachers regarding asthma management, as assessed by pre- and post-test scores (mean difference 18.28%, 95% confidence interval [CI] 12.29 to 24.27, mean difference 1.18, 95% CI 0.61 to 1.75, respectively. Asthma education programmes also led to a statistically significant increase in the proportion of school teachers who reported feeling prepared to manage asthma emergencies (risk ratio 2.32, 95% CI 1.26 to 4.28) and a statistically significant increase in the proportion of school teachers who reported having an asthma management plan in place for their students (risk ratio 2.27, 95% CI 1.20 to 4.31; (Kew et al., 2017). Moreover, an integrative review by Al Aloola et al. (2014) reported that relying on non-health care personnel, such as schoolteachers, to deliver asthma interventions may seem more sustainable; however, teachers' limited time and training on asthma education could represent a challenge (Al Aloola et al., 2014).

My review highlighted supervised asthma medication administration in school settings as a form of school nurse-led asthma intervention. Salazar et al. (2018) emphasised that school-supervised asthma therapy improves asthma outcomes. Although successfully implemented, they suggested that medication administration by school nurses causes an uncompensated workload

(Salazar et al., 2018). Schools with limited nursing services can establish a system to maintain the administration of preventive asthma medications, as seen in Halterman et al. (2018), where an asthma care coordinator who received additional asthma training was appointed to assist the school nurse in communicating with the physician, families and school. This role promotes a therapeutic relationship between the school nurse and schoolchildren; thus facilitating ongoing monitoring and education (Halterman et al., 2018). An additional strategy that may help to reduce school nurse workload while implementing such programmes is the electronic linkage between the hospital health record and school electronic health record so that the school nurse is aware of any change in the treatment plan.

3.5.2 School-Based Intervention Versus Nurse-Led Intervention

Many studies described school-based interventions targeting children, and these interventions showed improvement in asthma outcomes (Cicutto et al., 2013; Payrovee et al., 2014; Grover et al., 2016; Perry et al., 2018; Salazar et al., 2018) However, these programmes are sometimes short-term, delivered by research teams, or require additional resources, such as manpower or materials, that could affect the sustainability of the intervention. Asthma intervention programmes should be developed in schools to sensitise the school and community to self-management practice in the long run (Coelho et al., 2016). To enable practice sustainability and maintain asthma self-management skills, school nurses need to be involved in planning, implementing, evaluating and leading the intervention (Carpenter et al., 2013; Isik et al., 2020). School nurses are leaders in the development of programmes, policies and procedures provided to students in the school system (NASN, 2016). Therefore, at the policy development and implementation level, school nurses act as change agents to promote the concept of self-management of chronic conditions such as asthma. Accordingly, school nurse-led programmes are of particular importance to achieving sustainable evidence-based nursing care by creating a linkage between schools, hospitals and home (Carpenter et al., 2013). As studies in this review did not elaborate on school nurses' extent of involvement in intervention design, further research is needed to compare child health outcomes when asthma interventions are only delivered by school nurses versus developed and administered by school nurses.

3.5.3 3.5.3 School Nurses' Training Needs

The NASN framework for 21st Century School Nursing Practice includes leadership as one of the domains. Through school nurse-led interventions, school nurses contribute to the health and well-being of students (Hoekstra et al., 2016) as well as to their academic development (Yoder, 2019). In order for school nurses to lead asthma interventions, there is a need to assess their training needs in order to strengthen their competency in asthma assessment, management and education. Ongoing education for school nurses based on a theoretical framework is recommended. Yet there are a dearth of studies that identify the training needs of school nurses in competency-based education programmes (Shin & Roh, 2020). A recent scoping review of 151 studies investigating needs assessment approaches adopted to inform healthcare professional continuing education revealed a dearth of reporting on the development and administration of learning needs assessment tools. The review indicated that self-administered questionnaires are the most common method adopted for conducting needs assessments among health care professionals. There is a lack of reporting on the validity and reliability of needs assessment tools (Al-Ismail et al., 2022).

In summary, the review found that different school nurse-led asthma interventions carried out in schools can improve child health outcomes. Training of school nurses specifically supports sustainable interventions that can promote children's health (Carpenter et al., 2013).

3.6 Conclusion

Overall, this scoping review found that school nurse-led asthma intervention programmes had a positive impact on children's asthma-related outcomes. Several limitations identified in this review should be considered when planning a school nurse-led asthma programme in the future. First, the included studies did not explore the effect that school nurse-led asthma programmes had on several other outcomes, such as the frequency of asthma exacerbations and their severity. Second, the dearth of evaluation strategies for school nurse-led programmes requires investigation. It is not possible to draw a firm conclusion on the impact of school nurse-led asthma programmes without an in-depth evaluation of the outcomes, including a longer follow-up period for each outcome. Third, the wide variations in sample size, measurement tools, and the nature of school nurse-led asthma programmes in the studies reviewed require a more rigorous type of research designed to better illustrate how nurse-led asthma programmes are

beneficial in reducing asthma-related outcomes. Most interventions included in my review were short-term, individual programmes that lasted one year or consisted of four or less sessions. This reduced the impact of school nurse-led interventions by limiting the opportunity to reinforce the instructions in repeated spaced intervals. Finally, the sustainability of interventions is influenced by the degree to which school nursing services are available, as the partnership between the clinical system (clinical setting) and the public system (school setting) promotes long-term asthma outcome sustainability. Thus, as a member of an interprofessional team, the school nurse can act as a linkage between the health sector and the educational sector. This provides an important insight that should be further explored in future research.

Taken together, the findings highlighted in this review provide important practical implications in terms of ensuring the effectiveness of school nurse-led intervention programmes addressing asthma among school-aged children. These insights can guide the future development and implementation of such nurse-led programmes, which will ensure positive asthma-related outcomes.

Chapter 4: School Nurse-Led Education to Manage Children with Asthma at School: A Scoping Review

4.1 Introduction

As discussed in Chapter 3, school nurse-led asthma interventions had a positive impact on children's health outcomes, including medication use, correct inhaler technique, symptom frequency, school absence, quality of life, health care utilisation and asthma knowledge among children and their parents (Chapter 3, Section 3.4.5). School nurses are also essential contributors to school-based intervention programme planning, implementation and evaluation. Given the impact of school nurse-led asthma interventions on children's health outcomes, school nurses need to be well prepared to manage asthma in school settings. This chapter presents a scoping review of evidence about the educational preparation school nurses require in order to manage asthma effectively in school settings. This review was published in the Journal of Paediatric Nursing in 2021 (Al Kindi et al., 2021), and its research recommendations guided the direction and focus of the intervention for this PhD study.

4.2 Scoping Review Objectives

The purpose of this scoping review was to investigate what asthma education programmes are available for school nurses so as to prepare them for the management of asthma among schoolchildren and also to explore how school nurses are educated on asthma management. More specifically, the objectives of this scoping review were to:

(1) Investigate the evidence of education available for school nurses to manage asthma in schoolchildren.
(2) Assess school nurses' asthma training needs, access and barriers.
(3) Examine the preferred ways of delivering asthma training to school nurses.
(4) Identify research gaps in the existing literature in relation to the education programmes available for school nurses regarding the management of asthma in schoolchildren.

4.3 Scoping Review Methods

This scoping review and literature search followed the previously reported scoping review framework (Section 3.3), which examines how research is conducted on a given topic (Arksey & O'Malley, 2005) and identifies knowledge gaps and the scope of the body of literature in a particular field (Munn et al., 2018).

4.3.1 Inclusion/Exclusion Criteria

The PEOS framework guided the selection of included studies.

4.3.1.1 Types of Study

Studies eligible for this review were studies of any design that investigated the educational preparation of school nurses (programme, lecture, training, demonstration or continuing nursing education) regarding the asthma management of students in a school setting.

4.3.1.2 Type of population

For this review, school nurses were defined as specialized health care professionals who bridge the gap between health care and education by protecting and promoting students' health in order to enable normal development and promote academic success (NASN, 2019). Students included schoolchildren between 5 and 18 years of age. The type of schools included educational institutions that covered any of the following educational stages:

- Primary/elementary school: the first stage of formal education, usually grades 1-6, ages 6 to 11 years.
- Middle school: educational stage between primary and high school, grades 7-9, ages 12 to 14 years.
- Secondary/high school: the last 3-4 years of formal education, usually grades 10-12, ages 15 to 17 years.

4.3.1.1 Type of exposure

The review included any educational intervention, programme, session, seminar, lecture, training, or continuing professional development programme directed at, provided for, or administered to school nurses to enhance their asthma management skills and/or prepare them to care for students with asthma within a school setting. I was interested in any educational intervention directed at school nurses, from once-off sessions to periodic programmes.

4.3.1.2 Types of outcome measures

The outcome measure examined was the improvement in asthma management knowledge and skills among school nurses. This included school nurses' self-efficacy, competence, communication skills and use of asthma action plans.

4.3.1.3 Exclusion criteria

Clinical guidelines, editorials, letters, opinions and commentaries were excluded from the review.

4.3.2 Search Strategy

The search strategy included a systematic search of six major electronic databases and other literature resources. The electronic search included the following databases: Cumulative Index to Nursing and Allied Health Literature (CINAHL), MEDLINE, PubMed, Education Resource Information Center (ERIC), PsychINFO and EMBASE. Other resources included hand-searched reference lists of the retrieved studies and experts in the field who were contacted about unpublished or incomplete studies. Articles published from 1980 to the present were included to ensure inclusion of the most current literature. Only articles published in English were included due to the possibility of language bias when searching non-English databases as a result of limited experience and the possibility of an inaccurate translation. Searching specialised non-English language databases using search terms in the appropriate language requires a professional translator, which is costly. Search terms were adapted to maximise

results from each database. The search process was carried out between March 2020 and August 2020.

The search terms had three major components: asthma (asthma OR Asthmaticus OR asthmatic OR asthmatics), school (school* OR college* OR preschool* OR pre-school* OR junior school* OR high school OR high-school OR institute* OR “educational institution*), and nurses (nurs* OR nursing*). The search strategies were adjusted for each database. These terms were combined with the Boolean operator (AND) Table 4.1.

Table 4.1. Search Strategy

Concept 1: Asthma
Medline (EBSCO): (MH "Asthma+")
CINAHL: (MH "Asthma+")

PsycINFO: No index term

EMBASE: 'asthma'/exp

ASSIA: MAINSUBJECT.EXACT.EXPLODE("Asthma")

WHOLIS: descriptor search only

ERIC: DE asthma

Keywords = asthma*

Concept 2: Nurses
Medline: (MH "Nurses+")
CINAHL: (MH "Nurses+")

PsycINFO: No index term

EMBASE: 'nurse'/exp OR 'nursing staff'/exp

ASSIA: MAINSUBJECT.EXACT.EXPLODE("nurses")

WHOLIS: descriptor search only

ERIC: DE nurses

Keywords = nurs* OR nursing*

Concept 3: School
Medline: (MH "Schools+")
CINAHL: (MH "Schools+")

PsycInfo: No index term

EMBASE: 'school'/exp

ASSIA: MAINSUBJECT.EXACT.EXPLODE("Schools")

WHOLIS: descriptor search only

ERIC: DE schools

Keywords = school* OR college* OR junior school OR junior-school OR pre-school* OR pre school* OR high school OR high-school OR institute*

4.3.3 Study Selection and Date Extraction Process

4.3.3.1 Study Selection

The literature review search was conducted in consultation with the university librarian. Figure 4.1 illustrates the process of study selection according to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines (https://www.prisma-statement.org/). As shown, 1012 journal articles were identified and exported to Endnote reference manager. In Endnote, 283 duplicates were removed, leaving 729 papers to be screened. These were then exported into Covidence software. Screening of the title and abstracts of these articles was performed using Covidence software 2.0 (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia). A total of 985 articles were excluded, and 27 articles subsequently underwent a full-text review. The full-text review resulted in the exclusion of an additional 19 studies. Reasons for their exclusion are outlined in the PRISMA diagram. Eight studies were ultimately included in this scoping review.

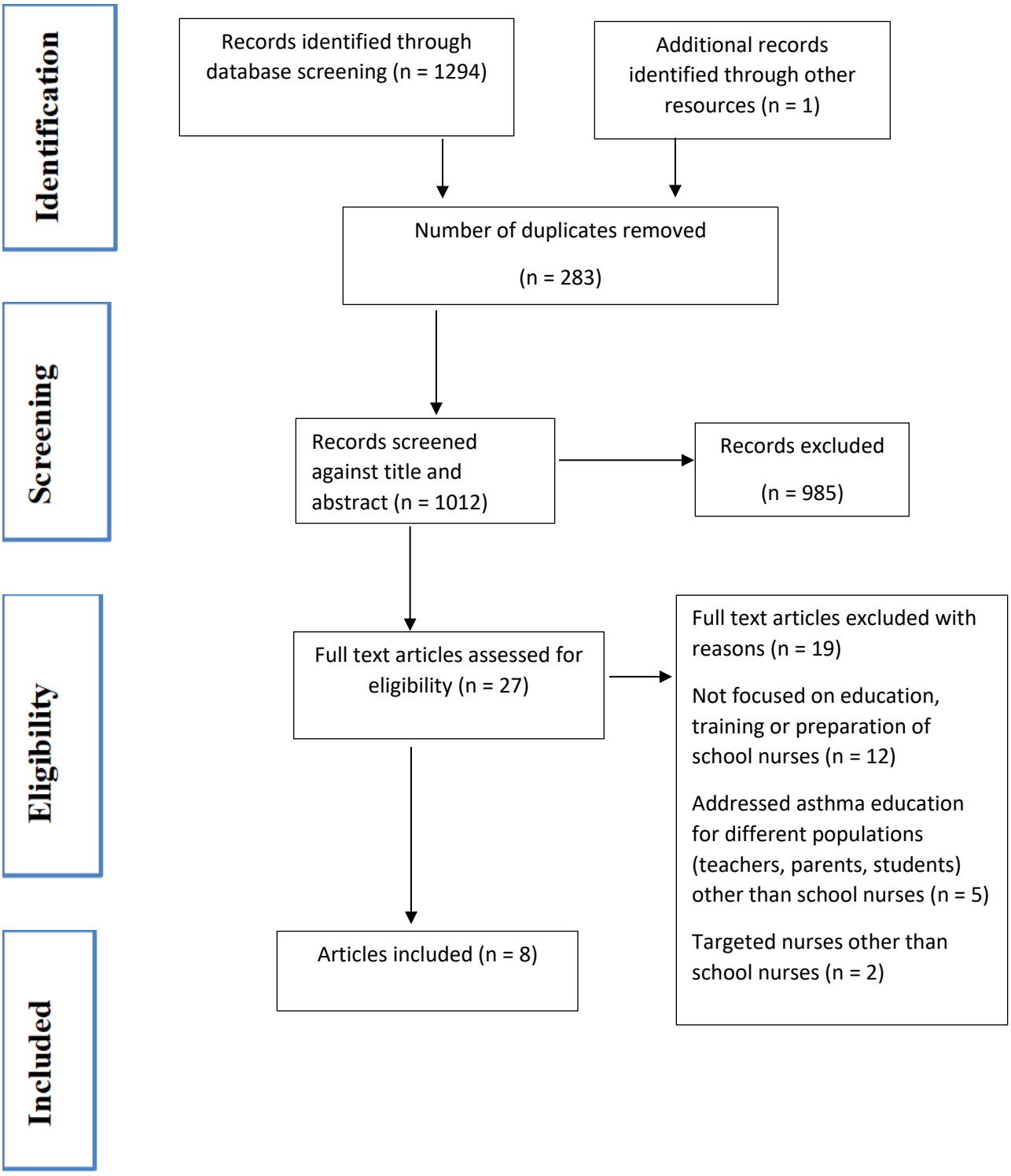

Figure 0.1. PRISMA Flow Chart

4.3.3.2 Data extraction

Data were extracted by me and reviewed by two other authors independently. There were no conflicts between the evaluators when selecting and extracting the data. Data were extracted into an evidence table that included the author, year, country, theory, design, population/sample, type of training (if available), topics covered, outcome assessed and interval of evaluation of outcomes (Table 4.2).

Table 4.2. Characteristics of the Included Studies

#	Citation	Objective	Study design	Population/Sample	Type of Training if available	Topics covered	Outcomes assessed	Interval of Evaluation
1	(Calabrese et al., 1999) USA	To assess school nurses' roles, responsibilities and function To examine health room policies related to asthma medication administration To review school nurses' asthma educational needs	Descriptive Level: IV≠	SN* (N=550)	No training. Survey: needs assessment	Needs assessment. No topics mentioned	Needs assessment to determine school nurses' asthma educational needs, training preferences and barriers to receiving education.	NA**
2	(Huss et al., 2001) USA	To determine the asthma-related practices and educational needs of rural school nurses	Descriptive Level: IV≠	SN* (N=550)	No training survey: needs assessment	Needs assessment topics not mentioned.	Needs assessment to examine rural school nurses' asthma educational needs	NA**

#	Citation	Objective	Study design	Population/Sample	Type of Training if available	Topics covered	Outcomes assessed	Interval of Evaluation
3	(Chao et al., 2003) Taiwan	To determine the competence and management efficacy of school nurses in caring for asthmatic students	Quasi-experimental Level: III≠	829 SN**	In-person, starting with: education needs assessment six months before intervention 4-hr training session using lecture, visual demo then programme evaluation.	Pathology, symptom identification, management 0f episode, medication, treatment, peak expiratory flow meter (PEF) demo	Asthma knowledge/competence Self-efficacy	Before and immediately after the education intervention
4	(Frankowski et al., 2006) USA	To develop a system to communicate asthma action plans with school nurses To organise a community meeting to discuss asthma resources available to school nurses To empower and support school nurses to implement an asthma education programme	Case study Level: V≠ Theory: Chronic care model The coordinated school health model	9 school nurses and 2 primary care physicians	Face-to-face educational session Coordinated school health for improving asthma care for school-age children Supply of spacers Support to conduct asthma education in schools New asthma action plans	Asthma management Asthma action plans	Communication between school nurses and primary physicians Use of asthma action plans	1 year
5	(Winkelstein et al., 2006) USA	To teach rural school nurses how to improve asthma management of children in the school setting.	Randomised Control Trial Level: I≠ Theory: Health	46 SN*	The intervention group received a face-to-face 6-hour workshop on theoretical content, Demo (PFM, MDI, Nebulizers, spacer)	Pathophysiology, triggers and irritants, current information about asthma medications and delivery devices	Asthma knowledge self-efficacy documentation and communication behaviour	At baseline after 1 year .

#	Citation	Objective	Study design	Population/Sample	Type of Training if available	Topics covered	Outcomes assessed	Interval of Evaluation
			Precede model Who delivers the education: certified registered nurse asthma educator		Dollhouse to help children identify triggers Received written materials and PFM to use and consultation with rural nurse consultant (RNC). The control group received asthma education guide only			
6	(Putman & Pinto, 2011) USA	To develop and pilot test distance learning technology as a method to deliver asthma education updates for school nurses	Quasi-experimental Pilot Study Level: III≠ Who delivers the education: certified registered nurse asthma educator	SN* (N=20)	(N=11) Intervention Live classroom (Web-based conference; online session) that can be recorded and viewed later. Communication between the instructor and learner (N=9) control group: received a school health personnel questionnaire and a gift card.	Pathophysiology medication and delivery devices	Asthma knowledge, management, communication skills and confidence.	NA**
7	(Ramos et al., 2014) New Mexico USA	To (1) describe disparities between the urban and rural professional school nurse workforce, and (2) identify how best to meet the continuing education (CE) needs of the rural school nurse workforce	Cross-sectional Level: IV≠	SN* (N = 311) working in public schools, kindergarten through 12th grade	No training Needs assessment through a survey	NA** No education given	Challenges faced by SN, continuing educational content most needed	NA**

#	Citation	Objective	Study design	Population/Sample	Type of Training if available	Topics covered	Outcomes assessed	Interval of Evaluation
8	(Carpenter et al., 2017) North Carolina USA	To (1) assess school nurses' perceived asthma training needs, (2) describe nurses' access to asthma educational resources and (3) identify urban-rural differences in training needs and access to resources.	Descriptive Level: IV≠	A convenience sample of school nurses (n=162) from two urban and five rural counties	No training survey to assess asthma training needs, access, preferences	NA**	Training needs, access to educational resources, urban-rural variation	NA**

Note:|| Randomised Control Trial, SN = school nurse; NA** = not applicable; , ≠ a Refer to level of evidence in Table 3.5*

4.4 Results

4.4.1 Study Characteristics

Of the eight studies included in this review, seven were from the US and one was from Taiwan. The designs of the included studies were as follows: randomised control, level I (n = 1: Winkelstein et al., 2006), quasi-experimental, level III (n = 2: Chao et al., 2003; Putman & Pinto, 2011), descriptive, level IV (n = 3: Calabrese et al., 1999; Huss et al., 2001; Carpenter et al., 2017), case study, level V (n = 1: Frankowski et al., 2006) and cross-sectional, Level IV (n = 1: Ramos et al., 2014). Only two studies provided details on the person delivering the education to school nurses (Winkelstein et al., 2006; Putman & Pinto, 2011;); the educator was a certified registered nurse asthma educator in both studies. The study populations ranged from 20 to 829 school nurses, with an overall total of 2,468 school nurses.

4.4.2 Demographics of School Nurses

The included studies lacked detailed reporting on the educational qualifications of school nurses, including certification. All studies (n=8) targeted school nurses with varying years of experience in nursing in general and school nursing in particular (Calabrese et al., 1999; Huss et al., 2001; Chao et al., 2003; Frankowski et al., 2006; Winkelstein et al., 2006; Putman & Pinto, 2011; Ramos et al., 2014; Carpenter et al., 2017). All studies provided the nurses' years of experience, except for the study by Frankowski et al. (2006). While 92% (n = 506) of participants in the study by Calabrese et al. (1999) were registered nurses, over half of the participants (59%, n = 322) had less than five years of experience as a school nurse, 28% (n = 155) had 6–15 years of experience, and 13% (n = 73) had more than 16 years of experience. The majority of the participants (80.9%; n = 525) in the study conducted by Chao et al. (2003) had worked in nursing for more than 10 years, and slightly more than one-third (39.5%, n= 239) had been working as school nurses for over 10 years. Thirty-four per cent (n = 204) had worked as a school nurse for 5–9 years. Across the eight studies, the mean years of school nursing experience ranged from 5 to 8 years overall (Huss et al., 2001; Winkelstein et al., 2006; Putman & Pinto, 2011; Ramos et al., 2014; Carpenter et al., 2017).

Four studies reported the educational qualifications of school nurses, which varied between licensed vocational, diploma, bachelor's or master's-level qualifications (Chao et al., 2003; Putman & Pinto, 2011; Ramos et al., 2014; Winkelstein et al., 2006). Overall, school nurses working in rural settings had fewer years of experience in school nursing, were less likely to have a bachelor's degree or higher qualification in nursing, were less likely to receive continuing asthma education and had less access to asthma education materials in their schools than those working in urban schools (Carpenter et al., 2017; Huss et al., 2001; Ramos et al., 2014). In addition, school nurses in rural settings were more likely to work in multiple schools (Carpenter et al., 2017).

4.5 Analysis

Analysis and interpretation of the extracted data were conducted using a thematic analysis approach. This method of analysis helps the researcher to extract information, identify evidence and analyse and present the emerging themes (Terry et al., 2017). Thematic analysis allows the researcher to examine data in order to discover common themes and display data according to similarities and differences (Clarke et al., 2015). In my review, this approach facilitates presenting school nurse available education studies in relation to their focus, teaching strategies, assessment and evaluation methods. The included studies on asthma education programmes among school nurses focused on four main themes: (1) asthma training programmes and preferred teaching methods, (2) urban–rural differences, (3) training needs, educational topics, and barriers to asthma education, and (4) impact of asthma education programmes on school nurses' knowledge and skills. A summary of the findings is presented in Table 4.3.

Table 4.3. Summary of the Findings

Author, Year, Country	Design, Methods	Data Collection	Study Participants	Findings
Aim: To assess school nurses' asthma educational needs and training preferences.				
(Calabrese et al., 1999) Maryland and the District of Columbia, USA	Descriptive Statistics	Tool: Needs-assessment survey developed by adapting "School Nurses' Asthma Awareness, Needs and Concern Survey" from a previous study completed in 1996	n = 550 school nurses	76% had not participated in any asthma education in the past 6 months 78% felt a need for further asthma education 51% reported a lack of available programmes to train school staff to manage students with asthma 24% identified issues with school policies for asthma management as a barrier. 22% did not have an emergency plan for each child **Training topics identified:** From most to least important: asthma medication, attack prevention, emergency recognition, medication side effects, psychosocial issues associated with asthma, early attack signs and asthma causes **Preferred training format identified:** From most to least preferred choice: informal conversations with physicians/nurses/health educators, demonstration, written materials, videos, panel discussions, computer education programmes and role-playing
Aim: To determine asthma-related practices and educational needs of rural school nurses				
Huss et al., 2001) Maryland and Washington, DC, USA	Descriptive Statistics	Tool: Needs-assessment survey approved by John Hopkins institutional review board	n = 550 participants from 23 of 25 school districts	**Rural school nurses were less likely to:** be licensed as registered nurses ($p < .05$), teach students asthma self-management ($p \leq .01$), conduct programmes to train school staff to care for students with asthma ($p \leq .01$), use a peak flow meter to monitor asthma ($p < .01$), make a referral ($p < .01$) **Identified educational needs:** Educational programmes tailored to their specific environment Peak flow meters and educational resources, such as videotapes, audiotapes, and computer games, to teach children about asthma self-management School policies and guidelines to facilitate delegation of asthma care activities Stay current with recent asthma information to enhance open communication with other health care professionals.
Aim: To determine the competence and management efficacy of school nurses in caring for asthmatic students				

Author, Year, Country	Design, Methods	Data Collection	Study Participants	Findings
(Chao et al., 2003) Taiwan	Quasi-experimental	Tool: A nurse evaluation questionnaire surveying demographics, asthma knowledge and case management. Needs-assessment survey six months before the intervention	n = 829 school nurses in public primary schools	**Immediately after the intervention:** Significant improvement in school nurses' knowledge and competence levels regarding effective asthma treatment, crisis identification and intervention ($p < 0.01$) 79% of the school nurses had no prior experience with a peak flow meter ≥ 70% of participants had never seen a peak flow meter; despite education, there was no improvement in peak flow meter use self-efficacy. **Identified educational needs:** Educational programmes on treatment medication modalities, peak flow meter application and inhaled medication administration.
Aim: To develop a system to communicate asthma action plans with school nurses, to organise a community meeting to discuss asthma resources available to school nurses and to empower and support school nurses to implement an asthma education programme				
(Frankowski et al., 2006) Rural Vermont USA	Case study	Tool: Tracking forms and monthly conference calls to explore and resolve communication problems	n = 9 school nurses and two primary care physicians	Significant increase in current asthma action plans on file for students with asthma ($p \leq .001$) Increase in the number of schools offering the Open Airway program. Community members trained to be Open Airway programme facilitators **Barriers to asthma education:** Primary care physicians failed to complete parts of asthma action plans, limiting school nurses' ability to carry out education. Barriers overcome included having school nurses filling in sections of the asthma action plans.
Aim: To teach rural school nurses how to improve asthma management for children in the school setting				
(Winkelstein et al., 2006) Maryland, USA	Randomised Control Trial	Tool: School Health Personnel Questionnaire (SHPQ) measurement of asthma knowledge, management and communication experience	n = 46 school nurses from seven rural counties	**After the intervention:** Significant increase in asthma knowledge in the intervention group ($p = .03$); however, at follow-up, no significant difference was noted between the intervention and control groups. Increase in asthma self-efficacy leading to improved peak flow meter use, metered-dose inhaler use and spacer use, as well as communicating with children and use of asthma action plans. No significant difference between groups at follow-up ($p = .55$)

Author, Year, Country	Design, Methods	Data Collection	Study Participants	Findings
				Barriers to asthma education: Time constraints, lack of confidence in their teaching ability, distance to travel to obtain additional asthma education
Aim: To develop and pilot test distance learning technology as a method for delivering asthma education				
(Putman & Pinto, 2011) Virginia, USA	A quasi-experimental design with pre-and post-test intervention	Tool: School Health Personnel Questionnaire (SHPQ) measurement of asthma knowledge, management and communication experience	n = 20 school nurses from two rural counties	A significant difference in school nurses' confidence between the groups in post-test scores (p = .005) A significant difference between groups in asthma management and communication experience scores (p = .025) The change in knowledge score after the intervention was modest. Distance learning technology is an option for overcoming barriers to face-to-face continuing education
Aim: To (1) describe disparities between the urban and rural professional school nurse workforce and (2) identify how best to meet the continuing education needs of the rural school nurse workforce				
Ramos et al., 2014) New Mexico USA	Cross-sectional	Tool: Survey instrument created by experts in school nursing, public health, emergency medicine and paediatrics. Tested by eight school nurses for cognitive content	n = 311 school nurses working in public schools, kindergarten through 12th grade	Rural school nurses were more likely to work in multiple settings (p < .0001) Rural school nurses were less likely to hold a nursing degree at the baccalaureate level or higher (p = .0002) or receive recent continuing education on anaphylaxis (p < .0001) and asthma (p = .027) **Preferred training format identified:** Onsite, in-service classroom training (p < .0001), followed by online educational courses accessed from home (n = 130, 41.8%) and telehealth (n = 14, 29.5%)
Aim: To (1) assess school nurses' perceived asthma training needs, (2) describe nurses' access to asthma educational resources and (3) identify urban–rural differences in training needs and access to resources.				
(Carpenter et al., 2017) North Carolina USA	Descriptive	Tool: Survey designed with input from measurement experts and school nurses	n = 162 school nurses from two urban and five rural counties	**Training needs identified:** Communicating the needs of students with asthma to others (n =144, 65%) Asthma trigger prevention (n = 89,54.9%) Care coordination with primary care providers (n = 78,48.1%) Asthma attack management (n = 73, 45.1%). **Preferred training format identified:** More interested in receiving an online (n = 105, 64.8%) than in-person (n = 74, 45.7%) asthma training session. **Urban–rural differences:** Urban school nurses were more likely to have access to asthma education programmes (p = .04) and age-appropriate asthma educational materials in their school (p =.003).

Author, Year, Country	Design, Methods	Data Collection	Study Participants	Findings

4.5.1 Asthma Training Programmes and Preferred Teaching Methods

Four studies examined asthma training intervention programmes delivered to school nurses (Chao et al., 2003; Frankowski et al., 2006; Winkelstein et al., 2006; Putman & Pinto, 2011), while four other studies assessed school nurses' asthma educational needs and training preferences (Calabrese et al., 1999; Carpenter et al., 2017; Huss et al., 2001; Ramos et al., 2014). Education training was delivered either face-to face (Chao et al., 2003; Frankowski et al., 2006; Winkelstein et al., 2006) via recorded videos or through online courses (Putman & Pinto,2011). The educational programmes included in the four interventional studies consisted of a one-off training session conducted in groups lasting 4–6 hours (Chao et al., 2003; Winkelstein et al., 2006; Putman & Pinto, 2011). Only one study conducted a needs-assessment prior to the delivery of the education intervention (Chao et al., 2003). Two studies assessed participants' knowledge at baseline and one year after the intervention was delivered (Frankowskiet al., 2006; Winkelstein et al., 2006).

The educational programmes in two of the interventional studies (n= 875) consisted of a visual presentation and a practical demonstration on the use of peak flow meters (PFM) and inhaled medication administration (Chao et al., 2003; Winkelstein et al., 2006). The educational training programme by Frankowski et al. (2006) differed from others, as the practical part of medication delivery devices was displayed through a laminated poster without any demonstration. Their study focused more on the use of an asthma action plan and the necessary collaboration between primary care providers and school nurses. In this study, school nurses received education on Coordinated School Health, a framework used to improve care for students with asthma.

In a quasi-experimental study by Putman and Pinto (2011), an adapted distance learning programme using a web-based asthma education session was delivered to 20 school nurses. The school nurses interacted positively with the instructor during the teleconference session, and the sessions were recorded for later viewing. There were 11 school nurses in the intervention group and nine in the control group. The intervention group from one county was divided into two groups. One group received a pre-recorded version of an asthma education module (asynchronous) and the second intervention group received the Asthma Distance Education Programme, a live, web-based lecture where nurses were able to interact with the instructor to

clarify doubts after watching the videos (synchronous). In the second intervention group that received the synchronous asthma distance education programme, the instructor guided the audience online and recorded the session for future viewing. Participants in both intervention groups (synchronous & asynchronous) completed the School Health Personal Questionnaire (SHPQ), a measure of asthma knowledge, management and communication. The control group consisted of participating school nurses from the adjacent county who did not receive any education. Postintervention, both intervention groups scored higher than the control group, with the asynchronous group having the best postintervention scores (17.2 ± 3.31) in asthma knowledge, followed by the synchronous group (16.8 ± 2.30) and the control group (15.4 ± 2.75). Post-test scores for asthma knowledge did not differ significantly between the groups. The synchronous group also had a significantly (p = 0.25) higher postintervention management and communication score (60.2 ± 9.30) compared to the asynchronous group (32 ± 2.85) and the control group (13.5 ± 1.25). There was statically significant difference between the groups (p =.005) in postintervention confidence, with both intervention groups (50.4 ± 6.8, 32 ± 2.85) scoring better than the control group (13.5 ± 1.25). The results indicated that distance learning technology is a practical method for delivering asthma education to school nurses.

In the study by Calabrese et al. (1999), school nurses were asked to indicate their preferred format for receiving asthma education from the most to the least preferred option. The results indicated that continuing education classes on current trends in asthma management were the most preferred format, followed by informal conversations with physicians/ nurses/health educators, demonstrations, written materials, videos, panel discussions, computer education programmes and role-playing. No statical figures were reported in this regard.

Ramos et al. (2014) reported that school nurses' preferred method for receiving education was through onsite, in-service classroom training (n = 311, 71 %; p < .0001), followed by online educational courses accessed from home (n=130, 41.8%) or from work (n=79, 25.4%). Teleconferencing was the least-preferred means of receiving continuing education (n = 39, 12.54 %; p = .0002).

By contrast, Carpenter et al. (2017) reported that school nurses were more interested in receiving asthma training online (n = 105, 64.8%) than in-person (n=74, 45.7%). They found that urban

and rural nurses equally desired additional asthma training. Nurses were more interested in topics related to the prevention of asthma triggers in a school setting (n = 89, 54.9%), care coordination with primary care providers (n = 78, 48.1%) and managing asthma exacerbations at school (n = 73, 45.1%).

In-person training sessions were predominant in the interventional studies included in this review (Chao et al., 2003; Frankowski et al., 2006; Winkelstein et al., 2006). One study adopted a distance learning method using live online teaching (Putman & Pinto, 2011). Regardless of the delivery method, the studies emphasised the need for hands-on practice when teaching medication administration and the use of a PFM (Chao et al., 2003; Putman & Pinto, 2011; Winkelstein et al., 2006). The duration of educational sessions, which were delivered within one day, varied between 4 hours (Chao et al., 2003) and 6 hours (Winkelstein et al., 2006). Studies that focused on needs assessment reported that the preferred duration of an education session was 4 hours (Calabrese et al., 1999; Carpenter et al., 2017). The duration of the evaluation period in the interventional studies was reported by two studies (Frankowski et al., 2006; Winkelstein et al., 2006). A period of one year from programme implementation to programme evaluation was used to assess changes in asthma knowledge, management and communication skills (Winkelstein et al., 2006) and the use of an asthma action plan by school nurses (Frankowski et al., 2006). At the 1-year follow-up, Frankowski et al. (2006) found a significant increase in current asthma action plans on file for students with asthma ($p \leq .001$) and an increase in the number of schools offering the Open Airway programme. Similarly, in Winkelstein's study, the changes were measured at baseline (before the intervention) and 12 months after the educational intervention, using the SHPQ. Winkelstein et al. (2006) reported a significant increase in asthma knowledge and self-efficacy in the intervention group (p =.03); however, at the 1-year follow-up, no significant difference was noted between the intervention and control groups. The results of these two studies indicate that knowledge was not assessed immediately after the delivery of the intervention nor at three- or six-months post intervention. Longitudinal knowledge assessment is crucial to ensuring knowledge acquisition and retention. It also helps to reveal the gap between actual performance and accurate performance.

4.5.2 Urban-Rural Differences

Three studies highlighted urban-rural variations and their association with access to asthma training programmes (Carpenter et al., 2017; Huss et al., 2001; Ramos et al., 2014). Huss et al. (2001) reported that, when in-service asthma education programmes are predominantly held in urban settings, rural school nurses have limited access to these programmes. This was reflected in their results, which indicated that rural school nurses were less likely to use a PFM to monitor asthma ($p < .01$), make a referral ($p < .01$) or conduct an asthma education session for training students or school staff ($p < .01$). Ramos et al. (2014) found that rural school nurses ($n = 83$, 76.2 %) were less likely than urban school nurses ($n = 168$, 86.2 %) to have completed asthma continuing education within the previous five years ($p = .27$). This finding was supported by Carpenter et al. (2017), who reported that urban school nurses were more likely to have access to asthma education programmes ($p = .04$) and have age-appropriate asthma educational materials in their school ($p = .003$) than their rural counterparts.

4.5.3 Training Needs, Educational Topics and Barriers to Asthma Education

One study conducted a needs assessment prior to the asthma education programme (Chao et al., 2003), while other studies focused on a needs assessment for the development of future educational interventions (Calabrese et al., 1999; Huss et al., 2001; Ramos et al., 2014; Carpenter et al., 2017). Chao et al. (2003) conducted a needs assessment six months prior to the implementation of an educational programme using a self-administered survey. The authors found that school nurses' competence and knowledge average scores regarding the use of PFM and proper asthma management following use of a peak flow meter reading were poor. The average sore pertaining to PFM monitoring was 2.08 out of 11. According to the study, 79% ($n = 626$) of participants had no prior experience with PFM and more than 70% ($n = 556$) had never seen a PFM. Sixty per cent ($n = 475$) of participants experienced difficulties in assessing the correct use of a bronchodilator ($p < .001$) and in instructing asthmatic children on how to use the metered-dose inhaler (MDI; $p < .001$; Chao et al., 2003). Similarly, based on a needs assessment survey, Huss et al. (2001) reported that rural school nurses showed a lack of awareness on the importance of referral to special care ($p < .01$), a lack of knowledge regarding PFM use in disease monitoring ($p < .01$) and less awareness of the importance of health education for students and caregivers ($p < .01$). Ramos et al. (2014) and Carpenter et al. (2017) also reported on the need for additional asthma training for school nurses. They reported that

school nurses were most interested in receiving education regarding trigger identification, care coordination with primary care providers and exacerbation management.

The topics covered in the educational sessions were similar between studies (Calabrese et al., 1999; Chao et al., 2003; Frankowski et al., 2006; Putman & Pinto, 2011; Winkelstein et al., 2006). The most commonly reported content was asthma pathophysiology, environmental triggers and irritants, asthma attack prevention, current asthma medications, delivery and monitoring devices. Taken together, the educational topics matched the recommendation of the Global Initiative for Asthma guidelines. GINA is a medical organization established in 1993 to reduce asthma prevalence, morbidity and mortality. GINA guidelines recommend the use of a PFM to monitor airway narrowing and to assess asthma symptoms. GINA also recommends the development of open communication between school nurses, other health professionals, and parents. More importantly, the accurate administration of inhaled medication is stated as being crucial for successful asthma control.

Although not the main focus of studies in this review, barriers to asthma education may prevent school nurses from receiving up-to date asthma education. Two of the included studies recommended investigating these barriers when assessing the asthma education received by school nurses (Carpenter et al., 2017; Winkelstein et al., 2006). The key obstacles identified were lack of financial support, difficulty in locating a workshop location that is suitable for all school nurses, scarcity of accessible age-appropriate educational resources, travel distance and time constraints. However, the acceptability of online asthma education programmes after Covid-19 pandemic can positively address the reported challenges. Yet, it is crucial to address potential technical barriers and incorporate interactive elements to enhance engagement and collaboration among participants.

4.5.4 Impact of Asthma Education Programmes on School Nurses' Knowledge and Skills

The education programmes in the three interventional studies positively impacted the school nurse participants' knowledge and skills (Chao et al., 2003; Putman & Pinto, 2011; Winkelstein et al., 2006). The interventional study by Frankowski et al. (2006) did not assess school nurses' knowledge. In the study by Chao et al. (2003), a pre-test was administered using investigator-

developed evaluation tool, and an asthma knowledge score was assessed before and immediately after the education programme. Participants showed a significant knowledge score improvement ($p < .01$) regarding identifying asthma triggers, asthma treatment, environmental control and exacerbation interventions. However, following the didactic skill teaching, the improvement in the proper use of the PFM and the management of asthmatic children after obtaining PFM readings was minimal. The majority of participants (n = 626, 79%) had no prior experience in using a PFM.

In the randomised control trial by Winkelstein et al. (2006), the mean knowledge score at the 1-year follow-up using the SHPQ improved significantly in the intervention group (n = 28; $p = .004$); however, no improvement was noted in the control group (n = 18). Seventy per cent (n = 32) of school nurses who attended the asthma training session reported that the knowledge gained from the training programme was utilised in their daily practice (Winkelstein et al., 2006).

Regardless of the training format, Putman and Pinto (2011) found that asthma training had a positive impact on the school nurses' perceived communication experiences ($p < .025$) and confidence levels ($p < .005$). However, the change in knowledge score assessed by the SHPQ immediately after the intervention was not significant ($p = .09$).

4.6 Discussion

This scoping review of the literature relating to available asthma education programmes for school nurses identified some research gaps. A variety of primary problems have been reported that should be addressed when planning an asthma education programme for school nurses. This includes the educational requirements of school nurses.

The American Academy of Paediatrics recommends a minimum of one full-time registered nurse in every school (Council on School Health, 2016; Holmes, Allison, et al., 2016). The NASN supported this recommendation and described the minimum educational requirement of a registered professional school nurse as a bachelor's degree from an accredited school and a registered nursing license through the board of nursing (NASN, 2016). However, the present review found that the basic educational qualifications of school nurses varied widely, even

within one country. As school nurses can become qualified through multiple educational pathways, there is a need to focus on asthma education through continuing education to maintain and expand competency. However, offering continuing education programmes focusing on asthma does not necessarily mean that nurses will be competent. Therefore, it remains necessary to explore school nurses' knowledge, competence and self-efficacy. Only one study assessed school nurses' competency in managing children with asthma at school (Chao et al., 2003), while three studies examined school nurses' knowledge and self-efficacy in asthma management after an intervention programme (Chao et al., 2003; Winkelstein et al., 2006; Putman & Pinto, 2011). McCabe et al. (2019) reported significant correlation between school nurses' self-efficacy and their behaviour in promoting health among schoolchildren with asthma ($r = 0.32$).

Overall, the differences in school nurses' educational qualifications, years of experience and continuing educational needs play an essential role in asthma management practice, as they may influence the demand for specific theoretical or practical asthma training sessions for school nurses. Therefore, training preparation must be tailored to meet various needs.

4.6.1 Investigation of the Evidence of Available Education for School Nurses for Managing Asthma in School Children

This review found limited reporting on the content of education programmes available to school nurses. The most commonly reported topics were asthma pathophysiology, identification and monitoring of symptoms, identification and prevention of triggers, exacerbation prevention and management and medication administration. Content changes reflected advances in technology for inhaled medication administration and updates on treatment and prevention strategies based on recent randomised control trials. Educators should consider delivering information based on current guidelines supporting asthma educational interventions that promote the acquisition of relevant skills (Cicutto et al., 2017).

4.6.2 Assessment of School Nurses' Asthma Training Needs, Access and Barriers

The review highlighted the variation in the needs assessment tools used to assess school nurses' asthma training needs. In order to assess training needs, Carpenter et al. (2017) used a 16-item

investigator-developed survey that only covered previous asthma training and perceived training needs. Ramos et al. (2014) developed a survey instrument to understand the needs of school nurses and identify challenges faced by school nurses working in public schools. The survey was not asthma-specific, as its domains covered the overall continuing educational needs and preferred means of receiving continuing education in relation to asthma, diabetes and suicide risk identification and prevention.

Chao et al. (2003) reported conducting a needs assessment six months prior to the intervention programme; however, no details about the needs assessment tool was reported. This is the only included study that carried out a needs assessment that was followed by a training programme. Asthma training programmes needs to be crafted to meet school nurses' needs. Once needs are determined, training can be developed.

Calabrese et al. (1999) and Huss et al. (2001) used the same needs assessment tool that investigated school nurses' roles, functions and educational needs in relation to asthma management. This tool was specifically developed for school nurses to assess their role and functions at school and their training needs in relation to manging schoolchildren with asthma.

This review illustrated the differences in access to continuing education that exist between urban and rural settings as well as the variations in education, qualifications, and years of experience between school nurses in these settings. There are several urban and rural factors that were not investigated in the included studies. These factors include access to care, exposure to certain triggers and school nurses' workloads. Inequality in access to health care is one of the factors contributing to an increase in school nurse workload (Morse et al., 2020). As school nurses in rural settings are more likely to work in multiple schools, their workloads may be increased even more. Previous research has shown that children in rural settings are more likely to have uncontrolled asthma (Lutfiyya et al., 2010), to be hospitalised for asthma (Knudson et al., 2009) and to receive minimal asthma care (Valet et al., 2009). In addition, children in rural areas are more prone to the effect of second-hand smoke and to have high rates of chronic bronchitis (Moyo et al., 2011). These reported variations between urban and rural settings can potentially influence educational training programmes received by school nurses. However, these studies compared rural and urban areas in the US, and their findings may not be generalisable to other

countries, although they may still be relevant to other countries when structuring educational programmes for school nurses.

4.6.3 Examination of the Preferred Ways of Delivering Asthma Training to School Nurses

This review illustrated the trend in methods used for delivering asthma education and the methods preferred by school nurses. The asthma educational delivery methods reported in the included studies varied significantly from 1999 (Calabrese et al., 1999) to 2017 (Carpenter et al., 2017). This change over time was the result of ongoing advances in teaching technology. The study by Calabrese et al. (1999) was conducted before the inception of the global use of the internet, smartphone technology and advances in education delivery technology. Face-to-face education was the primary method of teaching prior to the advent of the internet. With the availability of the global computer network, various types of distance education have become very popular. Cicutto et al. (2017) encouraged the use of both face-to-face and distance teaching methods for asthma education. Incorporating online sessions with face-to-face problem-based learning is a favourable method for school nurses (Cicutto et al., 2017). Telehealth and electronic record-keeping are two important methods suggested by Morse et al. (2020) for improving the practice of school nursing. These methods will remove barriers in access to care, facilitate communication with health providers and enhance access to continuing education, particularly in rural settings (Marcin et al., 2016).

The methods, techniques, procedures and processes of the training programmes were not explained in detail in the included studies. No study reported about the group size, and the teaching strategies varied between the four studies that delivered education to school nurses (Chao et al., 2003; Frankowski et al., 2006; Winkelstein et al., 2006; Putman & Pinto, 2011). In the RCT by Chao et al. (2003), authors relied on lecturing and visual demonstrations, and the instructors used video compact discs and paper teaching materials in their educational activities. The researchers encouraged participants to practice the use of PFM by giving away three prizes for correct responses to asthma questions. Frankowski et al. (2006) delivered face-to-face educational sessions on asthma guidelines using laminated posters. No practical demonstration was reported, and the teaching strategy was not clearly defined. By contrast, Winkelstein et al.,

2006 delivered a 6-hour face-to-face training session using the train-the-trainer model. School nurses practiced using peak flow meters, placebo asthma medications and delivery devices until they demonstrated proficiency. Putman and Pinto (2011) used active learning methods where school nurses actively interacted with the instructor through live web-based programming.

4.6.4 Identification of Research Gaps in the Existing Literature in Relation to the Available Asthma Management Education Programmes for School Nurses

When assessing the available asthma education programmes required by school nurses for effective asthma management, assessments of knowledge and skills are vital. Previous studies have reported the challenges encountered when managing asthma in school settings. Knowledge and skill deficiencies among school nurses and the health care team are consistently reported challenges (Nadeau & Toronto, 2016; Cicutto et al., 2017). Studies that included an asthma knowledge evaluation reported an improvement in school nurses' knowledge levels after the intervention (Chao et al., 2003; Putman & Pinto, 2011; Winkelstein et al., 2006). However, it is not known if this improvement was sustained beyond one year after the education session (Winkelstein et al., 2006). Moreover, given that data were only collected 12 months after the intervention, there is no way of knowing the short-term effect of the intervention on school nurses' knowledge or practice, as the retention of information and the timeframe for reiterating education were not assessed longitudinally. Furthermore, the improvement of knowledge may not be sufficient to improve health outcomes (Coffman et al., 2009) and does not necessarily reflect that a certain asthma programme is good. Other parameters affecting the quality of asthma care provided by school nurses included the number of schools, the number of students and poor communication with medical providers. However, the consistent use of a knowledge assessment tool will help to determine the knowledge improvement of school nurses.

The studies included in this review highlighted the inconsistency in the use of multiple knowledge instruments. Two of the included studies utilised the SHPQ (Putman & Pinto, 2011; Winkelstein et al., 2006), which has an acceptable reliability of $\alpha = 0.67$ and high content validity, as reported by an expert panel of a paediatric allergist and two paediatric nurse practitioners (Winkelstein et al., 2006). The SHPQ is a 20-item knowledge questionnaire

developed by Winkelstein et al. (2006) for school health personnel. Each question has four response options with one correct answer.

This review further found that regular continuing education sessions are required for school nurses to demonstrate competency. Many school nurses participate in existing asthma education and management programmes. The Building Bridges for Asthma Care Programme is a combination of two existing asthma programmes: the Colorado Step-Up Asthma Programme and the Easy Breathing programme. The Building Bridges programme provides materials and support for school nurses to manage asthma in schools and to act as a bridge between students, families, and primary care providers. The programme emphasises the prominent role played by school nurses in asthma management and has been reported to serve as a model programme for supporting asthma care in a school setting (Szefler et al., 2018).

Few of the reviewed studies assessed previous exposure to an asthma education programme before measuring asthma knowledge or management skills. Previous exposure to an asthma education programme may positively impact knowledge scores among participants. This lack of assessment may interfere with knowledge and skill assessment after a particular intervention. More importantly, the lack of randomised controlled trials on the topic of asthma education among school nurses reflects the need for further studies on school nurses' educational training. While randomised controlled trials may not always be feasible, studies with large samples that include measures of impact and economic costs are necessary and more practicable.

Several differences were found between barriers to receiving asthma education for school nurses and barriers to conducting asthma education by school nurses. This review found that time limitations, lack of financial resources, difficulty in finding a workshop location that is convenient for all school nurses and the distance nurses had to travel to the workshop were the most common barriers to receiving asthma education (Ramos et al., 2014; Winkelstein et al., 2006). The distance learning method, which consists of online asthma training programmes that can be accessed at anytime, anywhere and at the user’s convenience, may be a solution for overcoming these barriers (Putman & Pinto, 2011). The barriers encountered by school nurses also affect the asthma care that they provide to students (Quaranta & Spencer, 2016). Lack of

education programmes for school nurses limits their ability to provide education to students, parents, teachers and school staff.

In most studies that provided asthma training for school nurses, the outcome measurement focused on a change in knowledge, management, skills or self-efficacy immediately following the training. Only one study assessed school nurses' competence in asthma management. Future studies should use a unified framework for the practice of school nursing, allowing for the changes in practice to be sustained over time. Cicutto et al. (2017) developed the Colorado Competency Framework for Asthma Care in Schools based on the healthy learner model (Erickson et al., 2006) and capacity-building strategies (Hoyle et al., 2008). The framework used a Delphi consensus approach to determine the minimum competencies school nurses should have for providing evidence-based asthma care in schools. The competencies cover the following areas: pathophysiology, factors contributing to acute/chronic asthma, assessment of asthmatic students and their families, medication and delivery devices, behavioural and environmental modification, education plans, referrals and professional networking. This framework guided the development of continuing education curriculums for preparing school nurses to provide asthma care in schools.

In summary, there is a need for evaluating the available asthma education programmes received by school nurses, with a particular focus on hands-on skills. More importantly, the use of technology will further remove barriers to continuing education, and nurses need to be included in the planning and implementation of new programmes that adopt emerging technologies.

4.7 Limitations

This review was not without limitations. The eight studies included in this review comprised a total of 2468 school nurses, 66.4% of whom were from the US and 33.6% of whom were from Taiwan. In future studies, asthma education programmes available to school nurses in other countries should be investigated. Four studies included in this review reported actual asthma education programmes for school nurses and four studies focused on school nurses' asthma educational needs. Future studies should include a needs assessment followed by educational programmes, as well as an evaluation of programme outcomes.

4.8 Implications for School Nurses and Future Research

This review primarily reported study findings from the US. No studies were conducted in Middle Eastern countries, including Oman, which are geographically and culturally different to the US. Health care systems and supporting infrastructure in the Middle East are likely to be different to other settings. Moreover, there is limited quantitative evidence on the qualifications of school nurses, and the requirements for school nurses vary significantly, even within individual countries, despite the international recommendation of having a bachelor's degree in nursing and school nurse certification and of attending continuing education sessions. Thus, future studies are necessary in order to form baseline data and compare findings between countries.

The management of a chronic condition such as asthma requires continuing education. Continuing education is an ongoing process to ensure the application of evidence-based practice. Among health care professionals, the need for continuing education (Sargeant et al., 2018; Ramani et al., 2019) to support competence and remain updated with advancements in practice is well-established (Al-Ismail et al., 2022). Needs assessment is more likely to cause practice change, as teaching is directed to personal and practice needs (Hauer & Quill, 2011). There is a need to develop and implement continuing education for school nurses based on their training needs (Shin & Roh, 2020). Defining the gap between the knowledge that school nurses currently possess in-terms of asthma management and what should be accomplished could inform training programme development and evaluation.

Needs assessments can guide decisions and inform stakeholders on the educational priorities regarding asthma training for school nurses, who are integral part of public health system. The review highlighted the lack of detailed reporting of asthma training needs assessment among school nurses. The deficiency in needs assessment tool development and validity made the robustness or rigor of the data collection tools challenging to determine. However, this deficiency has been constantly reported in studies investigating learning needs among health care providers (Section 3.5.3). An area that received less attention is how to identify learning needs, which is a crucial initial step for continuing education (Pilcher, 2016). The review found that surveys were the most commonly used tools. Additionally, the included studies lacked the

use of reliable valid assessment tools that are specifically developed for school nurses. The quasi-experimental study that performed needs assessment prior to the intervention programme reported nothing about the needs assessment tool. Two descriptive studies used investigator-developed tools that limited their focus to the previous training received and perceived training needs of school nurses. The only needs assessment tool that was specifically developed to comprehensively assess school nurses' asthma training needs is 23 years old. This calls for a revised school nurse asthma training needs assessment tool.

Needs assessment findings should be followed by education programmes to meet the identified needs. This review illustrated the need for educational interventional study designs to determine the effectiveness of the provided continuing training programme. Education programmes strengthen school nurses' knowledge and self-efficacy to advocate for students' safety and participate in changing policies and procedures in the school setting. For example, a change in policy to allow school nurses to administer a quick-relief bronchodilator via nebulizer to a student with asthma after a nursing assessment could prevent the unnecessary utilisation of health services (Gormley, 2019). Additionally, school nurses play an essential role in environmental safety by applying trigger management strategies. Therefore, asthma education programmes for school nurses are necessary in order to ensure students' safety.

There was inconsistency in the use of knowledge assessment tools to assess school nurses' asthma knowledge across the studies. The review revealed the lack of tools developed for school nurses. Quaranta and Spencer (2015) developed a promising asthma knowledge questionnaire specific for school nurses, who are the key providers of asthma educational programmes in school settings. The 24-item questionnaire incorporated issues identified in the literature regarding factors affecting asthma management in the school setting (Quaranta & Spencer, 2015), and the validity and reliability of the instrument was established. The questionnaire measures school nurses' knowledge regarding scope of asthma, trigger avoidance and environmental control, assessment and monitoring, medication and medication delivery devices. It consisted of 24 close-ended items, with a higher score indicating greater knowledge. The tool was created using multiple earlier tools and underwent evaluation by the New York State Education Department and the New York State School Nurse Association (Quaranta & Spencer, 2015). In a study conducted by McCabe et al. (2019), this same tool was used to

explore factors associated with school nurses self-efficacy in providing asthma care. the elements linked to the self-assurance of school nurses in dispensing asthma care.

Only one study performed an assessment of school nurses' competence in asthma management. Competencies involve a combination of measurable skills, knowledge and abilities that constitute a nurse's performance (Kisut et al., 2022). Bandura (1997) argues that availability of information and education regarding a new behaviour is not sufficient for the adoption of a new behaviour. Instead, the likelihood that a person will perform a certain behaviour is assessed according to the person's beliefs that they have the knowledge and ability to perform that behaviour and that the adoption of the behaviour will result in useful outcomes (Bandura, 1997). These beliefs are referred to as self-efficacy. School nurses with optimal competence can promote student health and success (Graebe, 2019). Self-efficacy has been recognised as a crucial factor for performing behaviours in any workplace. An assessment of school nurses' self-efficacy in asthma care may help evaluate methods that increase self-efficacy, which in turn supports both nursing and students' outcomes (McCabe et al., 2019). Seger (2018) suggested two key factors for effective asthma management at schools: a solid asthma knowledge foundation and school nurses "belief that they can create a positive change in asthma management". A school nurses' competency assessment can inform nursing standards and ensure their alignment with the current standards. Research point to health care organisations as being responsible for ensuring nurses' competency in order to maintain safe and quality care (Heydari et al., 2016). Research focusing on school nurses' asthma knowledge and skills could inform the establishment of competency standards that ultimately inform the standards of the school nursing profession.

This review pinpoints the need for future longitudinal studies to examine the resulting changes over time and to evaluate the sustainability of changes in the practice of school nursing. Longitudinal assessment is essential to assess the long-term impact of training programmes and ensures the ongoing retention of knowledge and skills over time. Baseline data should be drawn before and immediately after programme implementation to assess the short-term impact of the training programme. To assess the long-term effectiveness of a training programme, the literature indicated a three, six, and 12 month follow up period.

There is no coherent body of knowledge regarding methods for asthma education and training for school nurses. With recent advancements in health teaching and learning, training programmes can involve active learning strategies such as problem-based learning and reflective learning. Effective teaching methods that have adequate means of improving school nurses' asthma management skills and students' clinical outcomes should be considered in future studies. The education delivery methods should be synchronized with global technological advances and the availability of smartphones. There are online applications through which nurses can access live clinical scenarios and participate in planning, implementing and evaluating a patient's care plan.

This review identified several challenges that school nurses encounter in attending a training session. Timing, location and format of the training programme should be fully recognised by governments and institutions to ensure that it is accessible and appropriate for all school nurses.

4.9 Conclusions

This chapter highlights the limited amount of research on the topic of asthma education programmes available to school nurses. The review raises several issues that should be addressed in future studies. Research and education have focused predominantly on the qualifications required for a nurse to become a school nurse. However, after qualification, there is a need to focus on the continuing education school nurses should receive in order to demonstrate their competency. The literature highlighted the burden of childhood asthma globally and in Oman in particular. By investigating the effectiveness of school nurse asthma education programming in Oman, this PhD project considers GINA guidelines that support educating health care professionals through programme implementation and evaluation. This research is also in synergy with research recommendations that promote assessing health care professional learning needs and the longitudinal competency assessment of knowledge and skills.

Evidence-based practice advocates for the use of *"real life research"* when investigating educational interventions aimed at changing practice. With this in mind, the implications for this PhD project are twofold. First, this study will focus on examining school nurses' learning

needs, which helps establish a national profile for school nurses in Oman. Secondly, the quasi-experimental design will ensure this PhD project is focused on real-world intervention.

The studies discussed in this chapter were implemented in the US or Europe, which limits their comparability. When structuring asthma education programming for school nurses in Oman, one must consider that no previous study has addressed this area of research in the country. Being the first study of its kind, there is a need for a potential needs assessment tool that fits the school nurse population in Oman and the existing health system. The delivery of asthma training programmes should ensure cultural and geographical relevance in order to eliminate possible related challenges.

Chapter 5: Research Methodology

5.1 Introduction

This chapter presents details of the aim of the study, the research objectives, the hypothesis to be tested and the research design. Also included are details relating to the theoretical perspective underpinning the study design. This is a prospective longitudinal study using a quasi-experimental, pre and post-test design.

5.2 Background of the Study

Chapter 2 (Section 2.8) outlined how asthma management in Oman is suboptimal and places children at risk for frequent exacerbation, predisposing them to suffer from asthma morbidity. Given the high asthma prevalence among children in Oman (Chapter 2, Section 2.6), it is essential that efforts focus on school nurses' education, as they are the first line of contact with children and families.

As outlined in Chapters 3 and 4, in the Middle East, there is no research on the learning needs of school nurses, nor on their available education in managing schoolchildren with asthma. There is a consensus within the literature and national and international guidelines that health care professionals need continuing educational programmes to inform the application of evidence-based practice.

Although asthma education programmes for school nurses and their impact on patient care have not been extensively studied to date, Chapter 3 showed evidence that school nurse interventions improve the health and well-being of children. Chapter 4 supports the paucity of rigorous research on how to educate school nurses on asthma management.

My PhD study was in line with GINA guidelines, which advocate for the continuing education of health care professionals to advance their knowledge and understanding of asthma management. Educational interventions promoting evidence-based practice are intended to increase learners' competence and promote life-long learning (Ilic & Maloney, 2014). Given

the lack of research on this topic and being the first study to establish baseline data regarding school nurses in Oman, this study made an essential contribution to the existing knowledge.

5.3 Aim of the Study

The purpose of this study was to examine the impact of the School Nurse Asthma Education Programme (SNAEP) on school nurses' knowledge and self-efficacy levels.

5.3.1 Research Objectives

The research objectives of this study are as follows:

1- Assess the role, functions, responsibilities and educational needs of school nurses in relation to asthma management in Muscat Governate, Oman.
2- Examine school nurses' asthma management knowledge and self-efficacy level before and after the intervention.
3- Implement SNAEP using GINA guidelines.
4- Evaluate the effectiveness of the educational programme on school nurses' asthma knowledge and self-efficacy level in Muscat Governate, Oman.

5.4 Hypothesis

We hypothesise that implementing SNAEP will have no effect on school nurses' knowledge and self-efficacy level in relation to asthma management in the school setting.

5.5 Theoretical Perspective

The theory underpinning this study comprises three basic elements: ontology, epistemology and methodology. Ontological assumptions are concerned with the nature of reality and existence, while epistemological assumptions describe how research proceeds and what counts as knowledge (Annells, 1996; Weaver & Olson, 2006; Cohen et al., 2018). The relationship between these elements begins with an ontology that defines epistemology, which, in turn, defines methodology, which, then, determines applied methods (Slevitch, 2011; Houghton et al., 2012; Otoo, 2020).

Positivism, also referred to as objectivism, is an epistemological position that relies on the concept that reality exists (Smith, 1983). Constructivist epistemology is another epistemological position associated with interpretivist research. Both of these epistemological positions (positivism and constructivism) have their place in nursing research.

From an epistemological perspective, this study takes a positivist position. I consider reality (knowledge) to be objective and measurable or quantifiable (Antwi & Hamza, 2015). Behaviour and cause and effect can be measured, and human activity can be anticipated (Khan, 2014). This study aims to assess school nurses' asthma knowledge and self-efficacy levels before and after their participation in an asthma educational programme; consequently, knowledge and self-efficacy can be measured and quantified using predefined measurable indicators. Using a deductive approach, the impact of SNAEP can be determined by the administration of pre-tests and post-tests to measure gain scores. Therefore, the study is broadly grounded in positivism to test the hypothesis. Objectivity of the research process is the major focus of positivism (Creswell, 2008). Knowledge is independent and objective and can be used to explain and predict a phenomenon regardless of its cultural or social context (Scotland, 2012). As such, quantitative methodology is used to determine cause and effect relationships and generalise findings about a phenomenon (Knapp, 1998).

5.6 Research Methodology

Given the aim of my study and the fact that positivism is the commonly used paradigm to test a hypothesis, the quantitative approach, as a derivative of positivism (Otoo, 2020), is the research method that best fits this theoretical underpinning and is the most appropriate to this research, as it would fit the research aim. Quantitative research strategy is a method used to test a certain hypothesis by collecting data that support or contradict this hypothesis. This type of research is most often concerned with quantifying the relationship between and among variables (Sukamolson, 2007). Quantitative research designs mainly use deductive reasoning and generalisation (Sousa et al., 2007). Deductive reasoning is the process in which researchers start with an established framework and gather the evidence to examine whether that framework is supported (Johnson, 2010). Researchers may choose quantitative research if a dearth of research exists on a particular topic in a certain area or if the topic investigated can significantly affect

patient care (Polit & Beck, 2012). There are several types of quantitative research, and the three broad categories of quantitative designs are experimental, quasi-experimental and nonexperimental (Rutberg & Bouikidis, 2018). While experimental design can demonstrate a cause-and-effect relationship, nonexperimental designs cannot.

5.6.1 Nonexperimental Quantitative Research

Non-experimental designs are used to describe or examine the associations between and among variables. As these designs use observation, there are no random assignments, control groups or manipulations of variables, as researchers do not intervene in the observation in any way (Blalock et al., 2018). There are two well-recognised designs associated with nonexperimental quantitative research, classified as descriptive and correlation. According to the timing of the data collection, they are further classified into cross-sectional or longitudinal. Based on the timing of the observation being studied, they can be retrospective or prospective (Sousa et al., 2007). In a cross-sectional design, variables are assessed at one point in time and the relationships between them are established. In a longitudinal design, data are collected at different points over time. If a present phenomenon is linked with factors or variables in the past, the design is called a retrospective study design, while if present variables are linked with future outcomes, it is identified as a prospective study design. Questionnaires are a commonly used method in non-experimental designs (Blalock et al., 2018). Correlational research designs are concerned with establishing the relationship between two or more variables without manipulating the independent variable; thus, causality cannot be clearly stated (Knapp, 1998). In contexts where experimentation is not feasible, such designs may be considered (Knappa1998). This correlational design did not serve the study aim to assess the impact of an intervention; thus, it was not deemed suitable.

5.6.1.1 Descriptive research design

Descriptive design is used when little is known about a phenomenon (Sousa et al., 2007). It describes what exists and determines the frequency of its occurrence. The results of descriptive research provide baseline knowledge that directs subsequent experimental, quasi experimental or correlational studies (Blalock et al., 2018). Survey research is a key type of descriptive research that enables the collection of data related to practice, knowledge, opinion and attitude (Ponto, 2015). Check and Schutt (2012) defined survey research as "the collection of information from a sample of individuals through their responses to questions" (Check & Schutt, 2012). Survey research can provide information on participants' characteristics, opinions and feedback, which can be used as the basis for programme development or to modify existing practices.

In order to draw appropriate conclusions from survey research, science has identified a scientific approach to specify the sample, collect the data and follow up with non-responders (Ponto, 2015). The goal of sampling strategies in survey research is to obtain a representative sample of the total population of interest, as it is often not feasible to include the total population. The sample must include participants with characteristics similar to the total population (Ruel et al., 2015). Data in survey research can be collected through the use of two common methods: questionnaires or interviews. Questionnaires may include demographic questions added to the instrument questions and can be self-administered or administered by a trained member of the research team. They can also be administered individually or in a group (DuBenske et al., 2014; Ruel et al., 2015). Questionnaires can be presented in a paper or an electronic format or a combination of both to ensure better sample coverage. As the first objective of this study is to assess the role, function and educational needs of school nurses in asthma management, a descriptive survey research design was best suited for Phase 1 of the study (Section 5.7.1). An initial needs assessment was required to determine the asthma education needs of school nurses. Data from this needs assessment study created an evidence-supported foundation upon which future training programmes can be built. It also identified gaps in school nurses' asthma management educational needs.

5.7 Phase 1: Design

5.7.1 Descriptive Cross-Sectional Design

A nonexperimental, descriptive, cross-sectional design was used to explore school nurses' asthma knowledge, role, function and responsibilities through needs assessment. The descriptive studies that use the administration of a questionnaire are known as survey research. Using a descriptive design as a first step enables the characterisation of the problem and the exploration of the relationship between identified variables. It also facilitates future research (Phase 2) to build on the study results.

Needs assessment is a systematic approach conducted for the purpose of exploring factors, setting priorities and planning interventions (Rouda & Kusy, 1995; Witkin & Altschuld, 1995). It is the collection and analysis of information that relates to the needs of affected populations and that will help determine gaps between an agreed standard and the current situation (Gupta, 2011). It takes place early in the programme so that it can assist with the selection of strategy to be used by the programme (Jackson, 2009; Gupta, 2011). There are two types of needs assessments: direct and indirect (McCawley, 2009). The direct form of assessment is conducted as a formal study by gathering data from participants themselves, as in this study. This produces data specific to the needs of individuals, while an indirect needs assessment uses secondary data by asking advisors to voice their opinions (McCawley, 2009). Indirect needs assessments do not require institutional approval, but a direct needs assessment must be approved institutionally, as is the case with this research. The type of information obtained through a needs assessment may be objective, as in test scores, or subjective, as in the needs expressed by individuals (DeSilets, 2007).

Conducting a needs assessment provides many advantages for programme planning. A hallmark of needs assessment is the expectation that an intervention will be the second step to identifying

the differences between the ideal situation and the actual situation (Gupta, 2011; Mazhisham et al., 2018).

Educational needs assessment is an approach to examining what individuals or groups need to learn (Grant, 2017). The needs could include skills or knowledge and may not be recognised by the learner as missing or lacking. Experts recommend educational needs assessment among health care professionals as a prerequisite of any educational training activity (Pilcher, 2016). In this research, the goal of the educational needs assessment is to determine what school nurses already know and believe so that the educational programme content can be determined. The second goal is to understand what can be done to make the educational programme more useful according to the school nurse's expected roles and responsibilities. Thus, phase 1 of this study is aimed at creating an evidence-base foundation for the development of asthma educational intervention for school nurses.

5.7.2 The Needs Assessment Process

According to McCawley (2009), when thoughtfully performed, a needs assessment should include the following core concepts:

Impact: An analysis of how education or training can affect the audience,

Approach: Knowledge about effective educational approaches,

Awareness: Data about existing programmes and gaps in available training,

Outcomes: Information about the current situation that can be used to document outcomes,

Demand: Knowledge about the potential need for future programmes, and

Credibility: Data regarding whether the programme is serving the target population.

Needs assessment is a twofold process that involves both identifying the existing problem and understanding how stakeholders can respond to the identified gaps with a programme or a service (McCawley, 2009).

The needs assessment survey used in this study incorporated the six core concepts reported above with an assessment of the existing asthma education programmes and the frequency of attending these programmes by school nurses. Table 5.1 below presents the summary of the suggested steps following McCauley's (2009) approach of a needs assessment and indicates how these were incorporated in this study. These steps are explained in detail later in the methods chapter.

Table 5.1. Needs Assessment Steps

Needs Assessment Steps	
Purpose What are the objectives of a needs assessment?	To identify school nurses' roles, functions, responsibilities and educational needs with regards to asthma management in a school setting.
Audience Who is the target population?	School nurses in all government schools in Muscat Governorate, Oman, Methods Chapter (Section 6.4)
Data Collection How will data be collected? What is the instrument?	Direct needs assessment from participants themselves. Instrument detailed in the Methods Chapter (Section 6.9.1)
Data Analysis and Prioritising the Needs	Needs were identified and prioritised based on the analysis of the survey.

5.8 Phase 2

Design

An experimental research design is used to examine the cause and effect relationship between the dependent and independent variables; however, this is conducted under controlled conditions (Burns & Groves, 1997). In experimental research, the independent variable is

actively manipulated. Manipulation refers to the control of the independent variable to assess its effect on the dependent variable. The experimental study design is further classified into true experimental design and quasi-experimental design. True experimental design has three essential components: manipulation, randomisation and control. This design didn't suit the study because the random recruitment of participants carries the risk of possible contamination. School nurses work in nearby schools four days a week and join the primary healthcare centre located in the same school area one day per week. Additionally, they work in the same healthcare centre during school vacations. Random allocation of the sample to different groups within the same county would have risked contamination between the groups, thereby affecting the validity of the findings. Consequently, it was not feasible to randomly assign participants to either an intervention group or a control group. As observed in previous research, random allocation of participants to different groups within the same school region would have risked contamination (Reichardt, 2009). Thus, a quasi-experimental design was considered appropriate for this study.

5.8.1 Quasi-Experimental Research

The prefix "quasi" means resembling (Price et al., 2015). Thus, a quasi-experimental design resembles an RCT, yet, it is not a true experimental design. Quasi-experimental designs differ from RCTs in their strategy of randomly allocating the sample to the intervention or control group (Siedlecki, 2020), as they may lack randomisation and/or a control group. Quasi-experimental designs are the most common design applied for the evaluation of an educational intervention (Gersten et al., 2005). They comprise a wide range of nonrandomised intervention studies and are used to establish the relationship between an intervention and an outcome. Quasi- experimental designs evaluate the intervention but do not use randomisation when it is challenging to randomise subjects due to ethical reasons or location (Maciejewski, 2020).

A significant advantage of a quasi-experimental design is that it requires fewer resources than RCTs, as it does not include a randomised or control group (Schweizer et al., 2016). These designs can be used to measure the impact of a particular intervention where data are reported and outcomes are assessed at multiple data collection times, such as monthly rates (Schweizer et al., 2016). This design can test the effectiveness of intervention, and later it can be used to

scale up the intervention to new setting (Handley et al., 2018). Therefore, the quasi-experimental design in this study is best suited to assess the retention of asthma knowledge and the change in asthma self-efficacy measures over time, as it can make full use of the longitudinal effect of the intervention (Kontopantelis et al., 2015).

Conversely, challenges can arise when not using randomisation in quasi-experimental designs, since the absence of a control group limits the causal conclusion between the intervention and the outcome (Maciejewski, 2020). This causal effect can be strengthened by collecting multiple outcome measurements for the same population over time and by using appropriate analytical methods (Schweizer et al., 2016; Maciejewski, 2020).

Quasi-experimental design can be classified into three main types: non-equivalent group designs, time series designs, or combination designs (Siedlecki, 2020). While non-equivalent groups lack random allocation of participants, time series designs have neither a control group, nor randomisation, such as a one-group pretest-posttest design. Combination design combines both a non-equivalent group design and a time series design like the *non-equivalent pretest-posttest design* and *non-equivalent pretest-posttest interrupted time series*. The first design allows for the use of the control group that receives no intervention but is assessed during the pre-test and post-test periods. The latter type allows the use of the control group and interrupted time series.

Phase **2** of this research involved an intervention programme and the measurement of its impact on participants' outcomes through multiple data collection points. As mentioned above, random allocation of participants to intervention and control groups would have risked contamination. Therefore, a one-group pre-test and post-test quasi-experimental design was best suited to answer the research question. Pre-test and post-test designs are multipurpose, can be used in experimental and quasi-experimental studies, and may or may not include a control group (Bell, 2012). When a treatment or intervention is administered to the study participants, changes may occur between the pre-test and post-test. These events alter responses to the post-test, indicating that the change in the post-test is due to the intervention (Burns et al., 2012). The purpose of this quantitative quasi-experimental study with a one-group pre-test and post-test interventional design is to examine whether the SNAEP is associated with the improved knowledge and self-

efficacy levels of school nurses who work at Muscat government schools. Under this quasi-experimental design, all participants were surveyed about their knowledge and self-efficacy levels at baseline, immediately following the SNAEP, and three months and six months after the SNAEP. The pre-test measured any differences that existed before the SNAEP to provide baseline information, and the post-test evaluated whether the SNAEP affected knowledge and self-efficacy development among school nurses. This form of follow-up mimics the longitudinal prospective studies in which the same participants are followed over a period of time (Caruana et al., 2015). These types of studies allow for the identification of changes over time at individual and cohort levels. Therefore, the study designs were a nonexperimental, descriptive, cross-sectional design in Phase 1 followed by a one group pretest-posttest quasi-experimental design in Phase 2.

5.9 Validity in Quasi-Experimental Designs

The inferences of the cause-and-effect relationship regarding the intervention and its outcome are important in a quasi-experimental design. However, there are factors that threaten the validity of the research and, thus, diminish the generalisability and the impact of the intervention. There are internal and external types of validity, and each depends on the study type, the population investigated, and the tool used. External validity refers to the extent to which the results of the study can be generalised, particularly to the population from which the sample was drawn or to other settings (Handley et al., 2018; Patino & Ferreira, 2018). Internal validity is defined as the extent to which the observed results represent the truth in the studied population and the extent to which the independent variable causes or affects the dependent variable and is not due to methodological error (Patino & Ferreira, 2018).

There are challenges to the quasi-experimental design internal and external validity that can be overcome through proper study planning and implementation, including establishing the inclusion/exclusion criteria, sample size, statistical power, data collection and data analysis methods (Maciejewski, 2020). It is critical to ensure validity in any quasi-experimental study, particularly for research questions for which there is no experimental evidence. The inclusion/exclusion of quasi-experimental criteria has an implication on the internal and external validity of the study. When the population is narrowly defined to specific demographic

or geographic area, the internal validity is enhanced over the external validity. At the same time, when the population is broadly defined, the external validity (generalisability) is enhanced at the expense of internal validity. The external validity threat was addressed by using a nationally representative sample of school nurses from the capital city of Oman with the highest density of schools and schoolchildren. School nurses who work in the capital represent nurses working in other governorates, as Muscat governorate residents represent residents from all over the country (Chapter 6, Section 6.5).

Data collections were planned to achieve the minimum needs of research without being burdensome to the participants (Methods Chapter, Section 6.8). The interval validity of this quasi-experimental design can also be strengthened through multiple rounds of data collection and can also be improved by conducting one or more preintervention assessment (Handley et al., 2018; Maciejewski, 2020). Extra data collection time points can compare data trends over time. This study used a needs assessment plan to gather information and used a baseline assessment directly before the intervention was delivered. The data were collected immediately post-intervention at three months and six months.

To strengthen the validity of the study design, the intervention should be delivered as intended and maintained over the study period (Handley et al., 2018). The intervention was administered to the participants fairly and consistently, using the same approach, same setting, same materials and same time period for the theoretical presentation and the practical demonstration (Methods Chapter, Section 6.9). Defining the primary outcome of interest in quasi-experimental designs is another aspect of ensuring study validity. It is crucial to ascertain that, if the intervention reveals an effect, the study has the potential to inform policies and/or change practices (Henderson et al., 1998). Therefore, the primary outcome variables should be valid, reliable, feasible and easy to determine (Maciejewski, 2020). As stated in previous chapters, outcomes in this study have been selected based on previous literature and on the baseline information obtained about the needs of the population. The validity of the study instrument affects the validity of the entire study. Therefore, it is essential to ensure the validity of the data collection tools. In this study, validity was assessed by five experts (Methods Chapter, Section 6.8.2).

5.10 Ethical Consideration

Like all other research involving human participants, nursing research applied the same ethical principles. The three core ethical principles of research are respect for persons, beneficence and justice (Heale & Shorten, 2017). In this section, I explore the ethical principles and how they governed the conduct of this study.

5.10.1 Respect for Persons and Informed Consent

The first core ethical principle is respect for others. Participants' "welfare is superior to the interests of the researchers, society or science" (Heale & Shorten, 2017). According to the Belmont Report (1979), which was issued by the National Commission for Protection of Human Subjects of Biomedical and Behavioural Research, respect for persons refers to autonomy and a person's right to voluntarily participate in a research study. An individual can make an autonomous decision once they are fully informed. Safeguarding participants is essential and includes strategies to mitigate possible emotional, financial or social harm (Hennink et al., 2020)

In this study, the right of each participant to make an informed voluntary decision on participation without fear of potential harm to their employment, position, well-being or career was respected. An important component of the informed consent process is full disclosure. Eligible participants were provided with written information about the study in the letter of invite (Appendix 6.4), participant information leaflet (Appendix 6.5) and copy of the informed consent (Appendix 6.6). Verbal information was given by explaining the overall study and the content of the informed consent and the participant information leaflet.

Participants were given one week to review the written information and every effort was made to address any queries. Participants who agreed to participate in the study had to confirm their voluntarily willingness by signing three consent forms as per the Good Clinical Practice Guidelines (Vadivale, 1999). Participants retained a copy of the consent form for their own records (Committee for Proprietary Medicinal Products, 1996). Participants' decisions to not take part in this study did not affect their employment, position or their future training opportunities.

5.10.2 Beneficence

The second core ethical principle is benefice, where researchers should strive to do no harm and maximise the benefits (Heale & Shorten, 2017). Although research is expected to directly benefit participants, it can potentially also benefit society as a whole (Polite & Beck, 2012). Therefore, harm should be weighed against anticipated benefits at the level of participants and society as a whole.

When this study was planned, anticipated harm and benefits were assessed. In relation to benefits for participants, it was expected that participating in this study would help nurses to gain knowledge about asthma management in school settings, yet it was not guaranteed that this knowledge would be sustained or translated into practice.

To minimise harm when planning the study, strategies to minimise harm to participants needs to be considered. In relation to harm at participant level, data collection tools do not include sensitive, embarrassing or upsetting questions. Possible discomfort may arise from the repetitive administration of questionnaires at different time points. In this case, participants were informed that they have the right to withdraw from the study at any given time.

In relation to benefits at the society level, the study findings may help by providing baseline information about school nurses' roles, functions, responsibilities and educational needs. This can be utilised to develop evidence-based interventions to promote school nurses' professional knowledge and self-efficacy in providing care to students with asthma in school settings. Identifying the current level of school nurses' knowledge and self-efficacy regarding asthma management can assist clinicians and healthcare managers in planning educational interventions that prepare nurses generally and school nurses specifically to provide high-quality care for children with asthma.

5.10.3 Justice

The third ethical core principle outlined in the Belmont Report (1979) is justice. This ethical principle is specifically concerned with the recruitment process and the equitable treatment of potential participants (Greaney et al., 2012). It is important to defend the inclusion and exclusion criteria in the study.

Within this study, the eligibility criteria were broad and directly related to nurses taking care of students with asthma at school. As the study began with a needs assessment survey of all school nurses in the Muscat Governorate, individual justice was achieved by giving all nurses the opportunity to express their asthma educational needs. Nurses working in private schools were excluded from the study because they are not under the umbrella of MOH and, therefore, are not expected to follow the same guidelines. The exclusion of non-English speaking nurses reflects the social justice that involves recruiting participants who are best-suited to answering the research questions. It is worth noting that all nurses in Oman are English speakers.

5.10.4 Confidentiality and Privacy

Confidentiality and privacy are important ethical principles that were not specified in the Belmont Report, yet are paramount to protecting participants. In this study, participants' confidentiality was maintained by using pseudonymised data, and no actual identification was used. Each participant was assigned a study identification code so that follow-up could be confidentially maintained across the data collection time points. The information obtained in this study will not be used in future studies without participants' consent. Documents were only accessible by me and my supervisors. Participants were also informed that they could have access to the data they provided at any time, and they could request a copy of the final report.

I collected and stored data in accordance with the General Data Protection Regulation (GDPR), Data Protection Act 2018 and Health Research Regulations 2018. All hard copies were secured in a locked cabinet in a private room at the researcher's office, and all electronic data were secured in a double encrypted computer on the researcher's desktop. Data will be kept for seven years from the submission data of the final report. After this period, the data will be destroyed according to the policies and regulations.

5.11 Summary

The School Nurse Asthma Education programme is directed towards training school nurses about asthma management. All school nurses working in Muscat governmental school were eligible to join the study. Due to the risk of contamination, participants were not randomised to intervention and control groups. One group pretest-posttest quasi-experimental design was

considered for this study. Participants' asthma educational needs were determined using a descriptive cross-sectional needs assessment survey in Phase 1. Using the assessment tools, the outcomes being measured and evaluated in this study are asthma knowledge and self-efficacy. The ethical principles of informed consent, respect of persons, beneficence, justice, confidentiality and privacy provide a framework for ensuring that participants were respected and protected throughout their participation in this study.

Chapter Six: Study Methods

6.1 Introduction

This chapter discusses the research methods used in this study based on the chosen methodology. The methods used in this study were ultimately determined by the theoretical perspective underpinning the study and selected based on methods capacity to answer the research question. As Chapter 5 suggested that positivists support knowledge as a quantifiable and measurable concept, and that human activity can be anticipated (Khan, 2014), the methods used in this study aim to quantify asthma knowledge and self-efficacy levels among school nurses.

Details relating to site access and recruitment are provided, followed by a discussion and outline of the data collection tools, their validity and the decisions that influenced their selection. Data were collected in two phases: once in Phase 1 and four times in Phase 2. The reasons for this methodology, ethical approval and issues relating to this study are outlined and discussed in this chapter, followed by a detailed description of the intervention programme and how it was conducted. The last section discusses the process for managing the data using SPSS Version 26 and identifies the statistical tests used for quantitative data analysis, along with a rationale for its use. Challenges encountered during study approval and intervention conduct are discussed in the relevant sections of this chapter.

6.2 Research Setting and Access to the Research Site

This study was conducted in the Muscat Governorate, a region of Oman that comprises six counties with approximately 1,385,493 inhabitants (Ministry of Interior, 2021). Included in the governorate is Muscat, the capital of Oman, which is located in the northern part of the country. Figure 1 (Appendix 6.1) illustrates the geographic location of the Muscat Governorate. Muscat's demographics can be considered representative of the national average, since, as the capital city and the largest metropolis in Oman, it is home to individuals from all over the country. There are 67 primary schools (grades 1-4) with 31,167 students in Muscat. There are 65 middle schools (grades 5-10) with a total of 48,597 students, and 21 secondary schools (grade 10-12) with a total of 14,485 students (National Center for Information and Statistics, 2016). The

number of schools and students is the highest in the Muscat Governorate compared to other regions of Oman. Therefore, Muscat Governorate schools were selected as the sites for the assessment survey. Schools from Al Seeb and Bawsher counties were selected as sites for the intervention phase of the study. There are 78 schools in Al Seeb and Bawsher counties, which accounts for 51% of the total number of schools in the Muscat Governorate (National Center for Information and Statistics, 2016). The reasons for selecting these two counties are discussed in Section 6.6.

For the intervention phase of the study, the plan was to administer the education intervention in the conference room of the Al Seeb Medical Centre, a primary healthcare facility in Al Seeb county. The selection of this location was based on the literature review, which highlighted challenges faced by school nurses in attending training programmes (Chapter 4, Sections 4.5.3 and 4.6.2). Common challenges included finding a workshop location that was convenient for all school nurses and the distance that nurses must travel to reach the training site (Winkelstein et al., 2006; Ramos et al., 2014). The planned workshop site for this study, which was easy to reach for nurses from both counties, was the conference room of the Al Seeb Medical Centre.

6.3 Ethical Approval

Ethical approval was granted by Trinity College Dublin on 8th April 2020 (Appendix 6.2), and Oman's Ministry of Education (MOE) and Ministry of Health (MOH) on 2nd June 2020 (Appendix 6.3).

6.4 Study Population

The allocation of nurses to schools is carried out by the MOH and depends on the number of students in each school. A nurse is responsible for one school when the number of students enrolled is greater than 1,000 and must cover two schools if the number of students enrolled is less than 1,000. Due to the general shortage of school nurses, which has been exacerbated by the COVID-19 pandemic, many nurses are required to cover three schools a week with student populations of less than 1,000. A school nurse's normal duty is to visit each school they are responsible for two days a week and to work one day in the primary healthcare centre in the

same school area. A primary healthcare centre typically offers outpatient clinics in various specialities, one of which is the asthma clinic.

The target population were nurses working in governmental schools in Muscat Governorate. It was not feasible to include nurses working in governmental schools in all governorates in Oman because of the geographic distance between governorates. For example, a 14-hour drive is required to travel from the far north governorate to the far south Governorate. Nurses working at private schools in the Muscat Governorate were excluded as they are not under the umbrella of MOH and would be expected to follow their own institutional protocol.

There are 153 governmental schools (primary, middle, and secondary) in the Muscat Governorate enrolling 94,250 students, and 143 schools are attended by 80 nurses who are part of the school nursing service (National Center for Information and Statistics, 2016). During the ethical approval stage of this study, I was notified by a representative of the school nurses in the Muscat Governorate that 10 nurses would be excluded because of their plans for retirement, which reduced the number of available schools for the needs assessment phase of the study to 143. Therefore, the total number of school nurses available in September 2020 was 70, with nurses covering 143 schools. All nurses (N = 70) were invited to participate in the needs assessment survey. For the intervention phase of the study, the number of nurses that were available in Al Seeb and Bawsher counties was 45 nurses covering 78 schools; all of these nurses were invited to attend the intervention programme. The 45 participating nurses cover primary, middle and secondary schools. The remaining 25 nurses were allocated to schools in the four counties (Qurayyat, Al Amerat, Mutrah, Muscat). Unlike schools in other counties in Muscat, all schools in Al Seeb and Bawsher counties have an available school nurse. Figure 6.2 indicates the total number of school nurses in the Muscat Governorate and the number of schools that have nursing services in each county in Muscat.

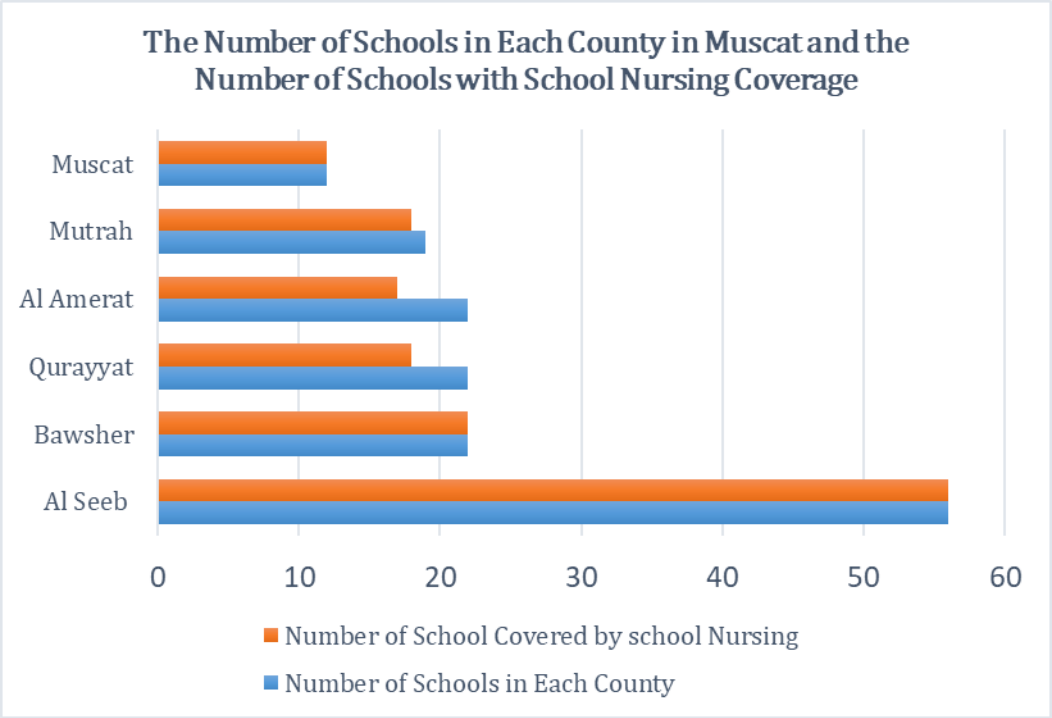

Figure 0.1. The Number of Schools in Muscat Governorate Counties

6.5 Eligibility Criteria

Inclusion Criteria. To be included in this study, participants had to meet the following inclusion criteria:

- Be a school nurse at a government school in the Governorate of Muscat
- Speak and understand English.

Exclusion Criteria

- Working as a school nurse outside the Muscat Governorate
- School nurses working at a private school, as private school nurses are outside the umbrella of the Ministry of Health in Oman. Only a few private schools have a school nurse, and of those schools, all nurses are from overseas. Their working environment and access to educational programmes is different from the rest of school nurses working in governmental schools.

6.6 Sampling

Phase 1

It was feasible to include all the target population for Phase 1 of this study. Nurses working in Muscat Governorate represent nurses in Oman. They had the opportunity to work in secondary and tertiary healthcare settings before moving to a primary healthcare setting and school nursing, as the Muscat Governorate is home to Oman's four tertiary hospitals. Additionally, with 12 nursing institutions in Oman offering a three-year diploma programme and three universities offering a four-year Bachelor of Science in nursing, the majority (72%) of Omani nurses are diploma holders providing general nursing care (Chapter 2, Section 2.9). It is expected that nurses working in Muscat Governorate will have this educational qualification.

Phase 2

For the intervention phase of this study, it was not feasible to include the entire target population; therefore, a sample of this population was selected. This sample includes nurses working in Al Seeb and Bawsher counties. There was greater confidence that the selection of these counties would lead to a more representative sample that had key characteristics of the target population. Section 6.6.1 justifies our reasoning for including nurses from the two counties for Phase 2 of the study.

6.6.1 Sample Size

Sample size calculation and the statistical power of a quasi-experimental design are highly important because they affect the validity of the study results (Maciejewski, 2020). The sample size of any study depends on several factors, including the accepted level of significance, power of the study, expected effect size, standard deviation of the population, aim and design of the study and expected dropout rate (Cady et al., 2000; Kirby et al., 2002; Suresh & Chandrashekara, 2012; Lakens, 2022). The target population of this study is school nurses who work at government schools in the Muscat Governorate. All school nurses in the governorate were invited to participate in Phase 1 of the needs assessment survey, and Phase 2 consisted of an intervention to be administered to school nurses in two of the six counties in Muscat. Reasons

for not delivering the intervention to all school nurses in the Muscat governate are discussed in Section 6.7. The following criteria assisted with the sample-size calculation for the Phase 2 intervention:

- **Location:** The preliminary data collected through the field assessment indicated that two counties in the Muscat region have the highest schoolchildren density and the highest enrolment of primary schoolchildren; therefore, a higher number of school nurses is allocated to schools in these counties. These two counties are Al Seeb and Bawsher counties, with an average nurse-to-student ratio of 1:616. Forty-five school nurses out of a total of 70 school nurses in the Muscat regions work in Al Seeb and Bawsher counties, covering 78 schools.

- **Software:** The G*Power software supports the calculation of sample size and power (Faul et al., 2009). Using G*power (version 3.1.2; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) with a significance level (α) of 0.05, median effect size (d) of 0.5 and power (1–β) of 0.95, the target number of participants was 45. The major reason for selecting a power at this level of significance is to avoid Type I and Type II errors.

6.7 Recruitment Process

Phase I

The recruitment process consisted of two steps: eligibility and enrolment. The process was conducted by the gatekeeper, appointed by the Department of School Health. The gatekeeper, who was an administrative employee, facilitated survey distribution across all sites. It is worth noting that the gatekeeper did not have any relationship with the potential participants. The initial recruitment phase included contacting the Department of School Health at MOH to obtain a list of potential schools with an available school nurse. Using the inclusion and exclusion criteria, private schools, governmental schools with no nurse and governmental schools with nurses submitting retirement requests were excluded. Records were kept for schools that were excluded as well as the reasons for exclusion.

When a school was deemed eligible, the process of enrolment commenced and a study information pack was prepared. A circular was sent by email from the MOH to the principals of eligible governmental schools introducing the study with a copy of the circular emailed to the assigned school nurse. I prepared a study information pack that included the letter of invite, participant information leaflets, consent, a copy of the needs assessment survey and a sealable envelope (Appendices 6.4, 6.5, 6.6, 6.7). I then gave an outline of what was included in the study information pack to the gatekeeper, who distributed the packs by hand to each eligible school nurse participating in the study. The gatekeeper explained the overall study, the informed consent and the participant information leaflet to the school nurses and provided each nurse with the researcher's contact details to clarify any issues or questions they may have. It was important to explain the study to the participants and assess their understanding prior to signing the consent form. Participants were informed that after a cooling-off period of seven days, the gatekeeper would revisit the schools to sign the consent form with nurses who decided to participate in the study. Nurses signed three consent forms in the presence of the gatekeeper, who also signed these forms. A copy of the consent form was returned to the participating nurses for their records, the second copy was kept in the school records, and the third copy was submitted to me. Nurses were encouraged to seal the completed survey with the provided envelope and keep it anonymously in a locked box in the principal's office for the researcher to collect within seven days after consent was signed.

The uncertainty around COVID-19 caused a two-month delay in opening schools for students to join 2020–2021 the academic year, and classes began in November 2020. This made it cumbersome to follow up with the nurses, as they were allocated to a number of difficult-to-reach COVID-19 centres, rather than to their school sites. Two-hour drives were necessary to collect some questionnaires for analysis. There were instances when nurses were moved between Covid-19 centres after receiving the study information pack. Therefore, during the period between signing the consent forms and collecting them, an electronic form of the survey was generated using Google Forms to obtain a maximum response rate. This online version of the survey was sent by email to all school nurses in the Muscat Governorate. Four email reminders were sent to participants before the decision was made to stop collecting responses. I revisited the schools to check if any completed surveys were kept anonymously in the locked

box at the principals' offices at 1 and 3 weeks after the distribution of the study information packs. I updated the Department of School Health about the response rate on an ongoing basis.

Phase 2

The initial plan was to include all school nurses in the Muscat Governorate in Phase 2. My reasons for not doing so related to feasibility as reported by the ethical committee of the MOH in Oman. At the time of field assessment, I was notified that releasing all nurses from their working sites would not be possible, as it would likely compromise their workflow. At the same time, Oman's Supreme Committee, which was tasked with managing the pandemic, issued restricting measures that banned gatherings of more than 10 people in one place, thereby requiring delivery of the intervention on separate days. Notably, the delivery of the intervention to a smaller number of nurses (10 to 15) at a time over four to six days has the potential risk of limiting the validity of the questionnaire findings when it comes to participants working in similar settings. Of particular interest, the primary outcome measures of the study were knowledge and self-efficacy levels. An available option was to postpone the delivery of the intervention with the hope that restrictions on gatherings would be eased. Seven weeks later, I was notified by the Department of School Health at MOH that I could conduct the programme on two consecutive days with a maximum capacity of 20 nurses per day and still adhere to the government guidelines regarding the spread of COVID-19. Based on the sample size calculation number that was estimated using G-Power, Al Seeb and Bawsher counties were best suited to benefit from the intervention for the reasons mentioned in Section 6.6.

Following the eligibility assessment and the governmental guidelines, all nurses working in governmental schools in Al Seeb and Bawsher Counties were invited to participate in Phase 2 of the study (n = 45). I met the representative of school nurses at the Muscat Governorate to facilitate the delivery of the intervention in Phase 2. The school nurse representative facilitated the reservation of the conference room at Al Seeb Medical Centre and sent an email to all nurses in Al Seeb and Bawsher Counties inviting them to attend a School Nurse Asthma Education Programme on 22-23 February 2021. Email invites were sent from the Department of School Health, MoH to 25 nurses to attend the programme on Monday, 22nd February 2021 and to 20 nurses to attend on Tuesday, 23rd February 2021 (9:00am -1:00pm).

6.8 Data Collection

The study used three data collection tools: a needs assessment survey, an asthma knowledge questionnaire and an asthma self-efficacy questionnaire. The following section describes each tool and the validation process.

6.8.1 Content Validity of the Study Instruments

As discussed in the Methodology Chapter (Section 5.9), content validity is essential to ensuring overall validity, as it provides information about the relationship between the content of the instrument and the variables under investigation as well as the appropriateness of the language (Alreshidi, 2015; Yusoff, 2019). This is determined by (preferably five) experts in the field (Zamanzadeh et al., 2015). Potential research participants can also be used as lay experts (Rubio et al., 2003). Researchers support obtaining validity evidence each time the instrument is used, as validity is not a property of an instrument. Instead, it relates to the score obtained by the instrument when it is used for a specific purpose (Waltz et al., 2010)

There is currently no agreement on the number of panel experts required to review the content validity of a specific tool. Lynn et al. (1986) suggest a minimum of three. Content validity for instruments in this study was determined by five experts: one community and mental health nurse expert, two school nurse health researchers, one public health researcher and one nursing administration specialist. This was a sufficient number of experts to perform the process of content validity, as acknowledged by Polit and Beck (2006). These individuals are considered experts in asthma management and are determined to be appropriate for this task.

Each reviewer was sent copies of the three questionnaires and was asked to evaluate each item using a 4-point Likert scale (Waltz & Bausell, 1981), with 1 = not relevant, 2 = somewhat relevant or needs major revision to be relevant, 3 = quite relevant or needs minor alteration and 4 = highly relevant and concise. Each reviewer was sent a copy of the questionnaire and was asked to evaluate each item based on an instruction and rating scale (Appendix 6.11). Reviewers were also asked to provide feedback on the items, indicate any necessary modification and suggest any further content that should be included. Quaranta et al. (2013) excluded items receiving a score of less than 15. The same criteria were applied for the needs assessment survey,

asthma knowledge questionnaire and asthma self-efficacy questionnaire. No item fell below the threshold for exclusion in the asthma knowledge and the asthma self-efficacy questionnaires. However, one question was excluded from the needs assessment survey. The following section describes the study instruments and discusses the results of the validation process and the modification made to the instruments used in this study.

6.8.2 Description of the Study Instruments, Validity and Reliability

Phase 1 Needs Assessment Survey

Phase 1 of this study used a validated instrument developed by Calabrese et al. (1999), researchers at Johns Hopkins University in Baltimore, Maryland, to investigate the role, functions and educational needs of school nurses in Maryland and the District of Columbia with regards to treating asthma. The survey instrument was developed according to the U.S. National Heart, Lung, and Blood Institute guidelines. This tool was selected because there is no available needs assessment tool that assesses school nurses' asthma educational needs. There are several tools for assessing asthma learning needs among patients with asthma or their caregivers. The tool created by Calabrese et al. (1999) was chosen because it is a comprehensive instrument developed specifically for school nurses that addresses their role, functions, responsibilities and asthma educational needs. As shown in Chapter 4, Section 4.6.2, there is dearth of needs assessment tools investigating school nurses' asthma learning needs. Despite being more than 20 years old, the tool created by Calabrese et al. was deemed appropriate to achieve the study objectives.

The original survey consisted of five components: demographic information, asthma awareness, school nurse role/functions, the role of the school nurse in asthma management and education/training. For the survey of this study (Appendix 6.7), the asthma awareness section was omitted because it included 14 questions assessing school nurses' asthma knowledge, which was investigated in Phase 2 of this study using another recent tool. Consequently, this study survey consisted of four components: demographic information, school nurses' roles and functions, school nurses' roles in asthma guidelines and training and educational needs.

As this study is the first of its kind to inform national policy, baseline demographic information that represents the overall Omani school nurse population was collected. The demographic section contained questions about the participants' age, gender, level of education, years of experience in nursing, years of experience in school nursing and any community or public health qualifications. The role and function section contained questions about the type of activities school nurses conduct in school settings and whether health assistants are available or not. Additionally, school nurses' roles in asthma management were evaluated using questions regarding medication and medication administration policy as well as the delegation of nursing actions. The asthma training section included questions about asthma education needs, available asthma training programmes, age-appropriate teaching materials, national and international asthma guidelines and essential topics that school nurses would like to see in asthma education programmes. Some items were open-ended, where school nurses were free to write any response. Others were close-ended items with options to choose from multiple choices, tick yes or no answers or indicate the frequency of a behaviour (e.g., 5=Daily, 4=Weekly, etc.).

Content Validity. Changes to the needs assessment survey were made following the reviewers' feedback: (1) the option "other" in the gender question was deleted, as it was reported by reviewers to be inconsistent with the Omani culture; (2) the word "post-qualification" in nursing was removed, as school nurses in Oman are working with a diploma or bachelor's degree in nursing or with a postgraduate degree in nursing; (3) the words "*school district*" were changed to "*school region*"; and (4) the question "*How do you feel about delegating nursing action to unlicensed personnel*" was changed to *"Delegating nursing actions to unlicensed personnel is part of my role (for example, a school teacher giving an inhaler)*; yes or no". One item was added: "*Please list the essential topics you would like to see covered in an asthma education programme for school nurses".* One question was excluded: "*Who provides the nebulizer machine for children who require a treatment during school?*". The reason for exclusion was that students who need the nebulizer are sent to the local health centre to receive treatment. The MOH is the only provider of nebulizer machines.

Reliability. The reliability of this needs assessment instrument was not reported in the literature. To determine reliability, the instrument was pretested using a pilot study (Section 6.10). Reliability of an instrument is measured by assessing its internal consistency (Ursachi et al.,

2015). Cronbach's alpha measures internal consistency between items on a scale. The internal reliability coefficient alpha was 0.65, and a generally accepted rule is that α of 0.6–0.7 indicates an acceptable level of reliability (Tavakol & Dennick, 2011; Ursachi et al., 2015).

Phase 2

Asthma Knowledge Questionnaire

Currently, there is no specific gold standard tool for measuring asthma knowledge for school nurses (Chapter 4, Section 4.6.4). The existing tools investigated asthma knowledge in children, parents and teachers. There are tools that were developed to assess parents' asthma knowledge and were also used to assess nurses' asthma knowledge, like the Newcastle Asthma Knowledge Questionnaire (Cabello et al., 2013). At the same time, investigators developed tools to assess asthma knowledge among physicians or pharmacists but not for nurses in particular. As mentioned in the literature review, there is a need for consistency in the measurement tools (Chapter 4, Section 4.8). This study used the asthma knowledge questionnaire developed by Judith Quaranta to examine school nurses' asthma knowledge (Appendix 6.8). It is a 24-item questionnaire that was developed by incorporating issues identified in the literature regarding factors affecting asthma management in the school setting (Quaranta & Spencer, 2015). The questionnaire measures school nurses' knowledge regarding scope of asthma, trigger avoidance and environmental control, assessment and monitoring, medication and medication delivery devices. It consisted of 24 close-ended items, with a higher score indicating greater knowledge. School nurses were asked to choose whether the statements were true or false.

The asthma knowledge questionnaire was used because it was specifically designed for school nurses (Quaranta, 2013). It included key information found in the international guidelines including asthma medication early recognition of asthma symptoms, particularly those suggesting an exacerbation and when to send the student to the emergency room. Kritikos et al. (2005) developed an 18-item health professional questionnaire to quantify general asthma knowledge among health care professionals. This tool was excluded, as it included a relatively high proportion of questions relevant to medication prescription, emphasising its use to quantify asthma knowledge among physicians or pharmacists, rather than nurses. It was used to assess

asthma knowledge among respiratory physicians and pharmacists (Kritikos et al., 2005). The Newcastle Asthma Knowledge Questionnaire is a widely used questionnaire that was developed to quantify parents' knowledge of asthmatic children (Fitzclarence & Henry, 1990). It was also used to quantify nurses' knowledge (Henry et al., 1993); however, the questions appeared to assess the underlying beliefs and behaviours of participants with supplemented knowledge questions. This was not deemed suitable for the purpose of this study.

Content Validity. To ensure that education regarding the management of asthma has been successful, an asthma knowledge questionnaire should be valid (Pink et al., 2009) and contain relevant items that are fit for the purpose for which it was designed (Luckie, Kate, Pang, et al., 2018). Based on reviewers' feedback, the statement reading "*A child with asthma with a peak flow reading of 85% of their personal best is considered in the yellow zone and should initiate their asthma action plan*" was changed to "*A child with asthma with a peak flow reading of 85% is considered in the yellow zone and should initiate their asthma action plan".*

Reliability. The 24 items in the asthma knowledge questionnaire used in this study were tested for internal consistency with a Cronbach's alpha level of 0.69, indicating that the internal consistency among items was acceptable.

Asthma Self-Efficacy Questionnaire

As discussed in Chapter 4 (Section 4.6), the studies that measured asthma self-efficacy among school nurses used an investigator-developed instrument (Chao et al., 2003; Winkelstein et al., 2006; Chiang et al., 2009; Quaranta, 2013). Chao et al. (2003) developed a 10-item Likert Scale questionnaire to measure school nurses' efficacy in asthma management. The questions focused on how school nurses teach and assist students with medication delivery devices, with one question about symptom identification and another about allergen prevention. In addition to being outdated, the survey was not considered adequate to measure school nurses' self-efficacy.

Winkelstein et al. (2006) developed a 15-item Likert-type scale measuring school nurses' self-efficacy in asthma care. Questionnaire items focused more on the degree of confidence that the school nurse had in teaching peak flow skills to children. Chiang et al. (2009) developed a 20-item asthma self-efficacy scale that focused solely on asthma teaching and was used to

investigate nurses' asthma teaching efficacy. It was not appropriate for the purpose of this study, which aims to explore school nurses' asthma self-efficacy, not only on the teaching side, but in all aspects of asthma management.

Self-efficacy in providing asthma care was measured using the asthma self-efficacy questionnaire, a more recent tool developed by Quaranta (2013) to assess school nurses' self-efficacy in providing asthma care in school settings. This instrument was selected because its 19 items incorporate recent issues identified in the literature to impact the asthma management of school nurses. As discussed in Chapter 2 (Section 2.5), these issues include trigger prevention and environmental control, medication delivery and adherence and exacerbation management. The Quaranta (2013) tool uses a 4-point Likert-type scale (Appendix 6.9), were a higher score reflects a higher self-efficacy. Permission to use this tool was obtained from the tool developer (Appendix 6.10).

Content Validity. The statement "*I can influence the student with asthma and their parents/caregivers to modify their home environment by teaching asthma environmental control*" was changed to "*I can influence students with asthma and their parents to reduce asthma triggers at home by teaching asthma environmental control*".

Reliability. Instrument reliability was established by the tool developer, with a Cronbach's alpha of 0.85. For this study, the internal consistency was checked to assess the extent to which items on the scale measured the same construct (interrelatedness). The Cronbach's alpha was 0.71, indicating good reliability.

6.8.3 Pilot Study

To determine the feasibility of the study and the assessment tools, a pilot study was conducted. Pilot testing is conducted to refine a tool or instrument to ensure clarity and understanding and to introduce any needed changes (Perry, 2001; Doody & Doody, 2015). This process strengthens the reliability and validity of the instrument (Fink, 2015). Multiple researchers, including medical field researchers, recommended that a pilot test should be conducted with the equivalent of 10% of the main sample (Lackey & Wingate, 1998; Julious, 2005; Connelly, 2008). Some researchers recommended that the minimum sample of pilot testing should be 12 participants

when there is no prior information to base the sample size on (Julious, 2005). Consequently, in this study, 12 nurses (17.14% of the main sample) from schools in the adjacent governorate were asked to complete the needs assessment survey. All responses were anonymous, and participation in the study was voluntary and confidential. School nurses who participated in the pilot test indicated that the survey took 20–25 minutes to complete. It is important to note that nurses who participated in the pilot test were not eligible to participate in the main study. No comments or suggestions for revisions were provided, because these nurses said the questions addressed their needs regarding asthma management issues in the school setting.

The asthma knowledge and self-efficacy assessment tools were pretested in a separate pilot study. Eight nurses (15% of the suggested target population) from Al Amerat and Matrah counties completed the pilot survey in a voluntary and confidential manner. Pilot study nurses indicated that it took a combined 30–35 minutes to complete both surveys. No further comments were given.

6.8.4 Data Collection Procedure and Timeline

Phase I Data Collection

The data collection process took place near the end of August 2020, and classes were expected to commence in September 2020. As reported in Section 6.7.1, study packs were distributed by hand and nurses returned the completed data collection forms by placing them in the principal's office for the researcher to collect. A period of seven days was given for nurses to fill out the surveys, assuming that each nurse completed the survey individually. Given the challenges reported in Section 6.7.1, I made two visits to the schools one week and three weeks after the distribution of the packs. I collected 27 completed forms, while 43 of the forms were unreturned. Seventeen completed forms were completed using the electronic link.

Reflecting on this experience, when I was initially planning to distribute the data collection forms for nurses in Phase 1 and school commencement was postponed, I was anxious about use an electronic survey, believing that this might negatively affect the response rate. Using the paper forms and electronic survey created extra workload for me in that I had to ensure that no duplication of the surveys existed. During data processing (pseudo anonymisation) it became

clear found that 7 nurses completed the electronic survey twice when several reminders were sent. This became evident because responses to all survey items were duplicated. Duplicated responses were excluded. No further responses were received after October 2nd, 2020.

Phase 2 Data Collection

As this was a prospective longitudinal study, four data collection points were included. This type of data collection approach is common when assessing the sustainability of educational interventions (Frankowski et al., 2006; Winkelstein et al., 2006; Alreshidi, 2015; Caruana et al., 2015). In this study, there were four data collection points: Time 1 (pre intervention), Time 2 (immediately post intervention), Time 3 (three months post intervention), and Time 4 (six months post intervention). Time 1 data collection was conducted on the day of the programme, immediately before the session began, by administering a paper form of the asthma knowledge and asthma self-efficacy questionnaires and was repeated at the end of the programme on the same day, at Time 2. Both questionnaires were readministered on two different occasions, three months and six months after delivery of the programme, by sending the questionnaires to the school nurses at their designated departments.

On the day of the programme, I introduced the study to the school nurses and administered the study information pack including the informed consent, participant information leaflet, asthma knowledge questionnaire and asthma self-efficacy questionnaire (Appendices 6.3, 6.8, 6.5, 6.6) and answered any queries they had. All attending nurses signed the consent form in the presence of the gatekeeper and I. A copy of the consent was retained by each nurse; I kept a second copy for my records. The nurses were given thirty-five minutes to complete both surveys and they returned both surveys to me by hand. After the end of the programme, I again administered the data collection forms by hand to the nurses, who were asked to drop them anonymously in a box located on a table in the room. I reminded them to complete the forms, which would be sent to them after three months.

Three months after the programme was implemented, copies of the surveys were sent by post mail to all schools in Al Seeb and Bawsher counties. Nurses were instructed to place the completed forms in their principals' offices seven days after receiving the forms. I interpreted

the completion of the survey as an informed consent to participate in the study. For time 3, I experienced difficulties getting the competed forms back. To prevent dropout, I sent a second copy of the surveys by post with a prepaid phone top-up card attached to each survey. I followed the same procedure for Time 4. In addition, I created an online form of the survey in which I interpreted the submission of the survey as an informed consent. This online survey was sent by email from the Department of School Health. Participants were encouraged to complete the questionnaire individually without researching the answers to the knowledge assessment questions.

Table 6.1. Data Collection Points for Phase II of the Study

Data Collection Time	**Asthma Knowledge Questionnaire**	**Asthma Self-Efficacy Questionnaire**
Time 1 Pre intervention	✓	✓
Time 2 Immediately post intervention	✓	✓
Time 3 Three months post intervention	✓	✓
Time 4 Six months post intervention	✓	✓

6.9 Intervention Design

In this study, the educational intervention was a specific asthma training programme tailored to school nurses. Learning theorists suggest that adults learn best when the topic is immediately relevant to them through experience and when the learning is problem-centred (Lenney et al., 2018).

The information from the needs assessment conducted in phase 1 informed the design and content of the education programme. The top topics school nurses listed as essential issues in

an asthma education programme were current asthma guidelines, medication delivery and medication delivery devices. Phase 1 also highlighted the limited use of peak flow meter by Omani nurses and the high frequency of exposure to children with asthma exacerbation in school settings. Additionally, findings indicated the presence of ambiguity around medication administration policies. Following completion of phase 1 of the data analysis and the identification and prioritisation of educational needs, and with more than half of the nurses not attending an asthma education programme in the past year, the content of the education programme prepared for community health workers by the Association of Asthma Educators was chosen because it included all of the elements identified as learning gaps by the school nurses. As the literature supported the need for hands-on skills trainings, this course has both a theoretical and a practical component. Additionally, the programme has the flexibility to support peer learning that has the potential to create an integrated learning environment for theoretical knowledge and clinical skills. The following section describes the programme.

6.9.1 The Association of Asthma Educators Asthma Programme

The Association of Asthma Educators was founded in 1998 as a non-profit organisation dedicated to providing quality education to multidisciplinary asthma educators. It represents healthcare professionals who identify themselves as asthma educators and is affiliated with the National Asthma Educators Certification Board (Association of Asthma Educators, 2022). The programme was carefully designed and reviewed by more than 35 asthma educators in the United States to ensure the provision of high-quality education for community health workers, including school nurses, who are part of a public health system. Additionally, the content was reviewed by two community health nursing specialists to determine the accuracy and adequacy of the information provided.

The educational intervention used in this study was derived from course content prepared for community health workers by the Association of Asthma Educators, and permission to use this material was obtained (Appendix 6.1.3). This programme was selected to suit the needs of school nurses in Oman, as it aims to prepare health professionals to effectively improve asthma care, provide asthma management education for clients and families and enhance understanding of the disease.

6.9.2 Intervention Overview

The intervention titled “School Nurse Asthma Education Programme” (SNAEP) supported the asthma educational needs of school nurses by providing training based on international asthma guidelines. It covered five modules: pathophysiology, triggers and environmental control, medications, medication delivery devices and assessment and monitoring. I personally delivered the content of the education programme to the participating nurses face-to-face. As an academic researcher with teaching experience, separating the educator role from the researcher role was one of my considerations. In order to maintain transparency with the school nurses, I explained my role as both a researcher and educator to them. Boundaries were established and my interaction with school nurses focused solely on my research objectives. Moreover, I assured the nurses that my role as an educator would not influence their behaviour or beliefs. I avoided expressing opinions that could influence the nurses’ responses to the surveys and ensured that I was being responsive to their questions and concerns.

Delivery of the programme was divided into a theoretical component (120 minutes) and a practical component (90 minutes) for a one-to-one hands-on skill training session. The theoretical session was designed to maximise nurses’ active participation by including instructional content and interactive learning activities to reinforce the learning objectives. The programme modules were presented according to the objectives of each module. Table 6.2 presents a detailed explanation of the learning outcomes of each module.

A clinical practical demonstration follows the theoretical component of the programme. As the literature supported the significance of demonstration and a return demonstration in skill acquisition (Luckie, Kate, Saini, et al., 2018), and with the Phase 1 findings suggesting the need for peak-flow meter measurement training, the practical session was planned to include the use of a peak flow meter and medication delivery devices (a dry-powder inhaler and a metered-dose inhaler). Participants were divided into groups of five and received demonstrations of the accurate technique for using each device. Each nurse was able to re-demonstrate the technique.

Table 6.2. Learning Outcomes of the Programme Modules

Module 1 **The Scope of Asthma**	**Module 2** **Triggers and Environmental Control**
Objectives	Objectives
1.1 Recognise the prevalence of asthma worldwide and in Oman. 1.2 Identify the impact of asthma on individuals and families. 1.3 Identify the four most common symptoms of an asthma episode. 1.4 Describe normal breathing and the main causes of airway obstruction. 1.5 Identify the role of school nurses in asthma care teams.	2.1 State the definition of an asthma trigger and explain the difference between an allergen and an irritant. 2.2 List the most common asthma triggers and their environment factors found in the home and school. 2.3 Identify asthma trigger environmental control strategies for home and school.
Module 3 **Medication**	**Module 4** **Medication Delivery Devices**
Objectives	Objectives
3.1 Explain the role of long-term controller medication. 3.2 Explain the role of quick-reliever medication.	4.1 Describe and demonstrate how to use a metered dose inhaler (MDI) 4.2 Describe how to use a dry powder inhaler (DPI)

3.3 Describe possible negative consequences associated with having uncontrolled asthma. 3.4 Recognise current asthma quick-reliever and long-term controller medications.	4.3 Describe how to use a nebuliser. 4. Describe when and how to use a peak flow meter (PFM).

Module 5 Assessment and Monitoring
Objectives

5.1 State the main risk factors for asthma-related deaths

5.2 Recognise the differences between asthma symptoms and asthma early warning signs

5.3 Explain the purpose of an asthma action plan and its individual components

5.4 Explain the purpose of a peak flow meter and demonstrate the correct technique for its use

5.5 Explain why validated questionnaires are useful tools in assessing asthma control.

6.9.3 Programme Procedure

I began the programme by introducing myself and outlining the programme objectives because nurse educators should use various teaching strategies to ensure that learning objectives and educational needs are met (King-Henderson, 2018). One of the most important components of nursing staff training is the teaching method (Carter et al., 2016). Regarding his own theory, educator Malcolm Knowles states that the main approaches for adult learning are problem-solving and collaborative research (Knowles, 1978). An active learner-centred approach that incorporates small groups, case scenarios and skills recording revealed positive effectiveness when used by nurse educators (Waltz et al., 2014). This process requires learner engagement and problem-based learning (Efstathiou & Bailey, 2012; Docherty et al., 2018). This study followed the learner-centred approach by adopting the procedural and teaching strategies outlined below:

- Participants were divided into groups of 5–6 members to enhance group discussion.
- In response to the gaps that were identified in Phase 1, a brief overview of the needs assessment findings was presented to participants to aid the discussion.
- Participants completed a warm-up activity at the beginning of each module.
- Interactive case studies were used, drawing on an in-depth analysis of real-life scenarios as a way to illustrate class content (Rowles, 2013). The literature supported using scenario-based learning to improve skills, behaviour and competence when teaching medical students and health care professionals (Cook et al., 2011; Helle & Säljö, 2012).
- Recorded videos were played to enrich the learning experience.
- Peer teaching and learning was applied and participants commented on each other's skill performances.
- Imagery was used when discussing the peak-flow meter and medication-delivery devices. Imagery is mental picturing or rehearsal before the actual use of information in practice; it is best used for the acquisition of psychomotor skills (Rowles, 2013).

- At the end of the programme, an asthma resource kit was given to each participant. The resource kit included a peak-flow skill assessment form, an asthma control test for children 4–11 years old and guidelines for managing asthma exacerbation.

6.10 Data Management and Analysis

6.10.1 Data Cleaning

The purpose of data management is to ensure that data are collected, recorded and analysed in an organised form. Data analysis started synchronously with data collection and was performed under the guidance of the supervisory team. In quantitative analysis, the numeral data are translated into statistical inferences which can then be interpreted in practice (Johnson, 2011). The processing of quantitative data was divided into a number of activities:

- Survey responses for the needs assessment survey, asthma knowledge questionnaire and asthma self-efficacy questionnaire were entered into a Microsoft Excel spreadsheet, and each response was given a numerical value for tracking purposes.
- I entered the data manually into the Statistical Package of Social Sciences (SPSS version 26).
- In Phase 2, to assess the longitudinal impact of the intervention, the analysis involved participants who submitted the questionnaires at the four data collection times.
- In Phase 2, the assessment of missing data was performed. The assumption was that for each missing item in an individual questionnaire, the mean over the observed item scores of other participants is calculated and imputed for the missing item observations. This method ensured an unbiased total mean (Rossi et al., 2013). In this study, missing data (missing values) were minimal, as the questionnaires were administered by the researcher in Phase 2 and by the gatekeeper in Phase 1.

6.10.2 Statistical Tests

Phase 1

In order to explore school nurses' asthma roles, functions, and educational needs in Phase I of the study, descriptive statistics were used. Frequency refers to the number of participants that

fit into a certain category, and percentages represent the part of the sample that corresponds to the category. Frequencies and percentages were calculated for nominal and ordinal data. For continuous data, means, standard deviation (*SD*) and range were calculated.

Descriptive statistics were used to describe the sample characteristics, the role school nurses play in the in school setting and asthma care activities that school nurses perform at school and the frequency of performing such activities. It was also used to assess the frequency of school nurses' exposure to asthma exacerbation and the frequency of attending an asthma training programme. A correlation analysis was used to describe the relationship between school nurses' demographics and the performance of some nursing care activities like use of a peak flow meter, attending an asthma education programme and delegating nursing actions to unlicensed personnel. Additionally, the correlation analysis was used to explain the relationship between exposure to a child with an exacerbation and attending an asthma educational training. A narrative analysis was used to analyse the open-ended question related to the essential topics school nurses aim to address in an asthma training programme.

Phase 2

For Phase 2 of the study, in order to detect and analyse changes over time, a *t*-test was considered. Since the aim of the study is to assess the impact of the SNAEP on school nurses' knowledge and self-efficacy, parametric *t*-tests were used to determine the differences in school nurses' performances across the four data collections. A *t*-test is a type of parametric statistical test that is used to compare the mean of two groups (Lumley et al., 2002; Field, 2009). It can be divided into two types; independent *t*-test, and paired *t*-test, which is also called student *t*-test. The independent *t*-test is used when the groups under comparison are independent of each other, while the paired *t*-test is used to compare the number of changes occurring in the same sample (Field, 2009). This study used the same sample across the four data collection times. Paired sample *t*-tests can detect the changes in school nurses' knowledge and self-efficacy levels across time.

A paired sample *t*-test has four assumptions (McCormick & Salcedo, 2015; Kim & Park, 2019):

- The dependent variable (knowledge and self-efficacy level) should be measurable at the interval or ratio level.
- The independent variable consists of related samples, which is the same sample of school nurses across the data collection time points.
- There should be no significant outliers impacting the validity of the results.
- There is a normal distribution of the differences between the paired values (McCormick et al., 2015).

For the fourth assumption, multiple researchers argued that the *t*-test is robust against mild to moderate violation of normality (Kishore & Jaswal, 2022). According to the Central Limit Theorem, a parametric method can be used for a large sample (30 or more) even when data are not normally distributed (Field, 2009). Normality assumption becomes less important as the sample size increases (Lumley et al., 2002; Field, 2009; Kwak & Kim, 2017). Kwak and Kim (2017) have also supported that, according to the Central Limit Theorem, "if the sample size is 30, the sampling distribution approximates the standard normal distribution and is considered normal" (Kwak & Kim, 2017). At a degree of freedom of 30, the paired t-distribution is considered as equal to normal distribution (Kim, 2015). As the sample size in Phase 2 of this study was (N=36), the *t*-test was deemed to be useful in detecting changes in school nurses' asthma knowledge and self-efficacy levels. In this study, the *t*-test was used to understand whether there was a difference in asthma knowledge and self-efficacy levels among school nurses before they received the SNAEP, immediately after delivery of the programme and again three months and six months later. The dependent variables were asthma knowledge and self-efficacy levels among school nurses in Muscat, and the two or more related groups were the four different time points.

In addition to the *t*-test being valid for use in this study, as most data are normally distributed, data that are not normally distributed were also tested using a Wilcoxon signed-rank test. This was done for the sake of comparison between findings. The Wilcoxon signed-rank test is the non-parametric form of the *t*-test, which does not make any assumptions about the underlying distribution of the data. Kim and Park (2019) argued that when data does not follow normal distribution, there is no guarantee that it is centred on the mean. The drawback of such non-

parametric tests is that no effect sizes are calculated (Sainani, 2012). The following section provides a detailed description of data distribution for Phase 2 assessment tools.

6.10.3 Distribution of Data

6.10.3.1 Data Distribution of Asthma Knowledge Questionnaire

Distribution was checked using the Shapiro-Wilk test, histogram plot, skewness and kurtosis (Field, 2009). According to the Shapiro–Wilk test, asthma knowledge questionnaire data were not normally distributed at Times 1 or 2 but were normally distributed at Time 3 and approximating normality at Time 4. Table 6.3 presents the data distribution according to the Shapiro-Wilk test for asthma knowledge, and Figure 6.3 displays the distribution of the asthma knowledge questionnaire data in the four data collection time points according to the Histogram of normality.

Table 6.3. Data Distribution of Asthma Knowledge Questionnaire According to the Shapiro–Wilk Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Time 1 Asthma Knowledge	.238	36	.000	.792	36	.000*
Time 2 Asthma Knowledge	.230	36	.000	.922	36	.014*
Time 3 Asthma Knowledge	.132	36	.112	.960	36	.221
Time 4 Asthma Knowledge	.179	36	.005	.939	36	.047

Df = Degree of freedom Sig: statistical significance *non-normal distribution

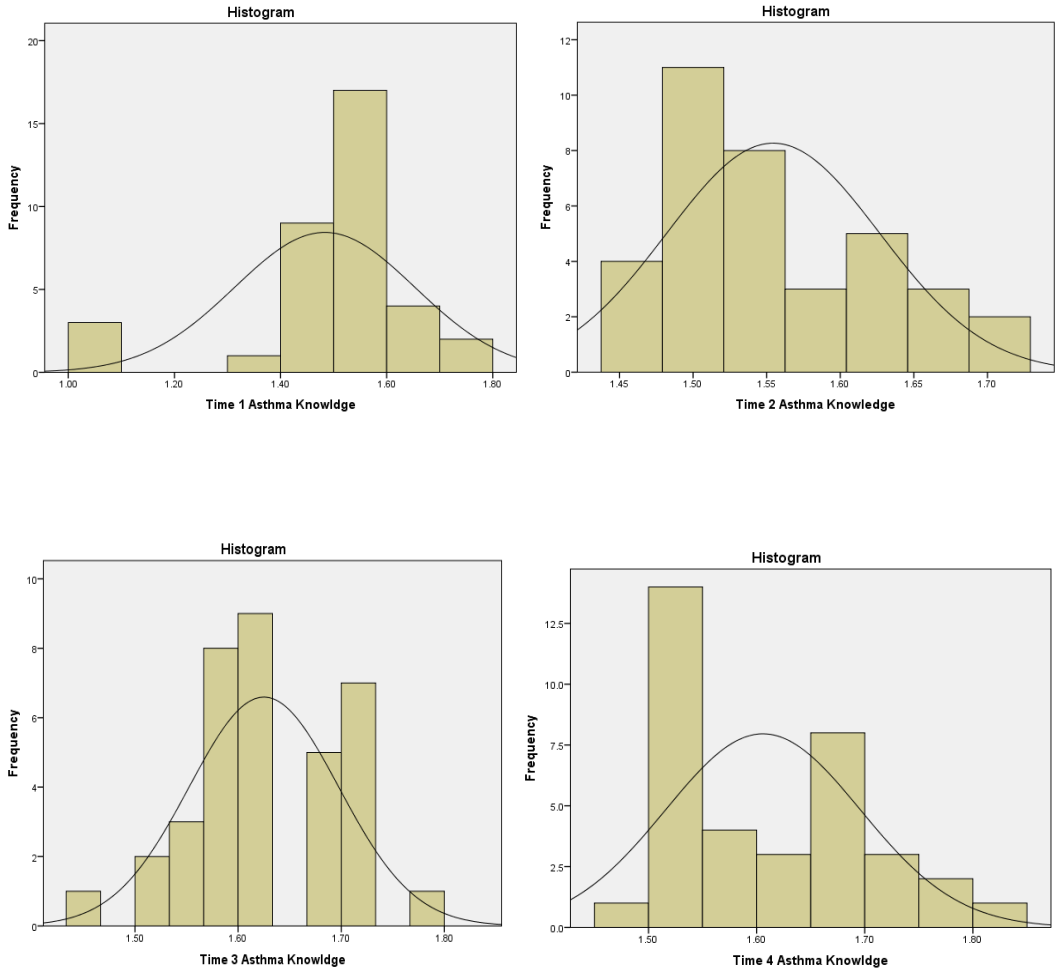

Figure 0.2. Histogram of Data Distribution of Asthma Knowledge Questionnaire

6.10.3.2 Data Distribution of Asthma Self-efficacy Questionnaire

According to the Shapiro-Wilk test, asthma self-efficacy questionnaire data are normally distributed for Times 1, 3 and 4. Table 6.4 presents data distribution for the asthma self-efficacy survey according to the Shapiro-Wilk test, and Figure 6.4 displays the distribution of the asthma self-efficacy questionnaire data from the four data collection time points according to the histogram of normality.

Table 6.4. Data Distribution of the Asthma Self-Efficacy Questionnaire According to the Shapiro-–Wilk Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Time 1 Self-Efficacy	.127	36	.155	.951	36	.112
Time 2 Self-Efficacy	.127	36	.154	.934	36	.032*
Time 3 Self-Efficacy	.104	36	.200	.959	36	.200
Time 4 Self-Efficacy	.141	36	.067	.941	36	.055

Df = Degree of freedom Sig: statistical significance *non-normal distribution

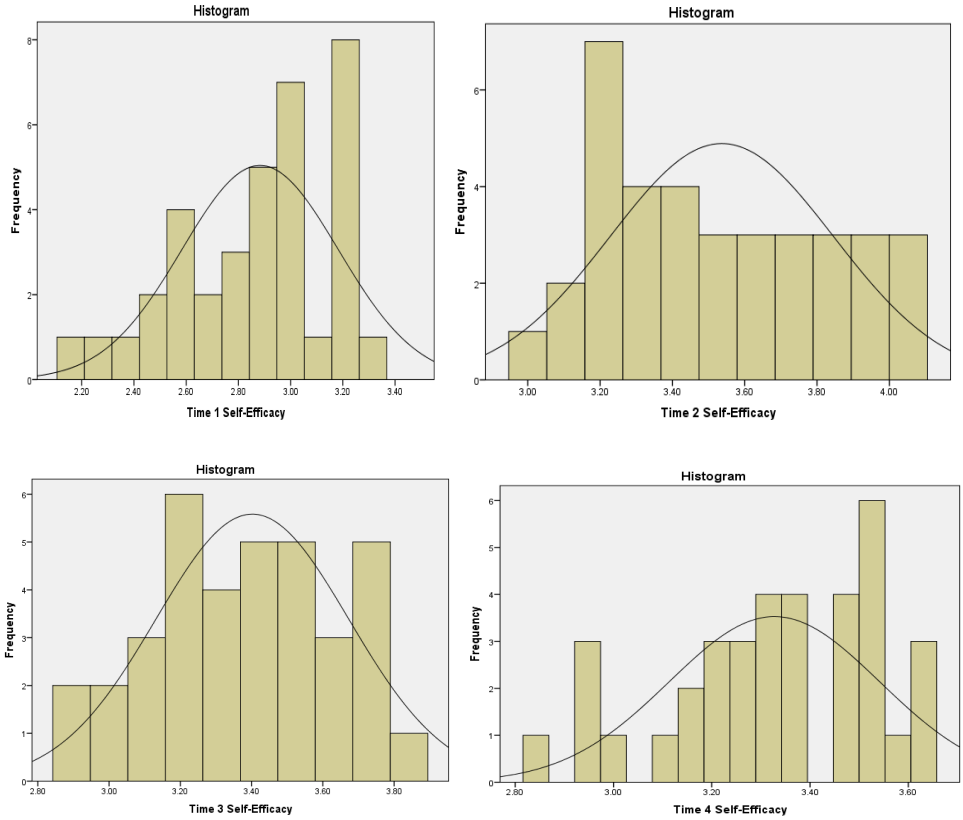

Figure 0.3. Histogram of Data Distribution of the Asthma Self-Efficacy Questionnaire

Based on the assessment of data distribution using SPSS and according to the above justification in section 5.11.2, the parametric paired samples *t*-tests were conducted for subjects who returned all four questionnaires in the pre-tests and post-tests. The comparison of parametric and non-parametric tests is sometimes important in particular medical settings where clinical results can impact patients' health (Lumley et al., 2002). In this study, I compare the results of the *t*-test and Wilcoxon signed-rank test when data are not normally distributed.

6.11 Summary

This is a pre-post quasi-experimental study that aims to investigate school nurses' asthma knowledge and self-efficacy levels after the SNAEP. This chapter has discussed the methods used in this study and has presented a detailed description of each phase of the study, including ethical approval to conduct the study, sample size calculation, instrument description, data collection and methods of analysis.

The methods used in this study are based on the ultimate aim of this quasi-experimental study to assess the impact of the SNAEP on school nurses' asthma knowledge and self-efficacy levels. The data collection tools being used were tested for validity and reliability.

The integration of problem-based learning and skill demonstration was effective in running the educational training in a smooth and interactive way. The pilot study was useful in ensuring the feasibility and clarity of the instruments used. An evaluation of the issues relating to survey collection in Phase 1 assisted with better planning for survey collection in Phase 2.

As there are different distributions of the data, in Phase 2 of this study, a t-test was used with all data that are normally distributed. For data with non-normal distribution, a Wilcoxon signed-rank test was considered.

Chapter Seven: Research Findings

7.1 Introduction

This chapter presents the findings of the SNAEP. All participants were followed with for up to six months after intervention implementation. The findings are presented for each phase of the study in this chapter. The purpose of Phase 1 was to identify the role and function of Muscat Governorate school nurses in asthma management and to explore their asthma education needs. Phase 2 measured the knowledge and self-efficacy levels of Muscat Governorate school nurses in providing asthma management care for schoolchildren before and after the completion of the SNAEP. Statistical tests were two-tailed, with a p-value below 0.05 considered statistically significant. Information on the data analysis strategy can be found in Chapter 6, Section 6.10. This chapter reports on the findings from each phase of the study.

7.2 Phase I: Needs Assessment of School Nurses in Muscat Governorate, Oman

7.2.1 Demographics

The number of government schools in Muscat Governorate totalled 153 (Chapter 6, Section 6.4), 143 of which employed school nurses. Invites were sent to the 143 school, and only 110 responded, so the response rate from the schools was 76.92%. These schools were attended by 70 school nurses, who were invited to participate in the survey. In total, 49 school nurses returned the survey, giving a response rate of 70%.

The majority of school nurses were female (87.8%, $n = 43$), and 12.2% were male ($n = 6$). The mean age was 37.7 years old ($SD = 5.036$), with ages ranging from 30–60 years. School nurses aged 35–39 years comprised more than half of the participants (51%, $n = 25$; Table 7.1).

Table 7.1. Demographics (N = 49)

Age (years)	Frequency	Percentage
30–34	9	18.4%
35–39	25	51.0%
40–44	10	20.4%
45–49	4	8.2%
60–64	1	2.0%
Mean Age (SD*)	37.73 (5.04) years	
Educational level	Frequency	Percentage
Diploma in nursing	44	89.8%
Bachelor's degree in nursing	4	8.2%
Other	1	2.0%
Years of nursing experience	Frequency	Percentage
6–10	7	14.29%
11–15	16	32.65%
16–20	22	44.90%
21–25	3	6.12%
31–35	1	2.04%
Mean (SD)	15.76 (4.76) years	
Years of Experience in School Nursing	Frequency	Percentage
1–5	21	42.86%
6–10	25	51.02%
11–15	1	2.04%
16–20	1	2.04%
31–35	1	2.04%
Mean (SD)	6.59 (5.22) years	

*SD = Standard Deviation

Nurses' educational qualifications ranged from a diploma for most school nurses (89.9%, *n* = 44) to a bachelor's degree (8.2%, *n* = 4). Only one nurse reported having a post-qualification community or public health nursing certificate. Years of nursing experience among school nurses ranged between seven and 33 years. Less than half of school nurses reported having 16–20 years of nursing experience (44.9%, *n* = 22), whereas 16 (32.65%) indicated having 11–15 years of nursing experience and one had 33 years of experience in nursing. The mean number of years in school nursing was 6.59 years (*SD* = 5.220). More than half of the school nurses

(51.02%, *n* = 25) had 6–10 years of school nursing experience, followed by 1–5 years for 42.86% of the sample (*n* = 21).

The mean number of schools for which each nurse was responsible was two (65.36%, *n* = 32). In total, only 22% of school nurses (*n* = 11) worked at one school, with 4% working across three schools. Nurses working across multiple schools indicated spending an average of 7 hours per day, 2 days per week at each school. Table 7.2 lists the total number of schools in each county, the total number of nurses linked to each county, and the total number of school nurses who completed the survey in each county.

Table 7.2. Distribution of Schools and School Nurses Across Counties in Muscat Governorate

County name	*Number of schools	Number of nurses	*n*** (%)
Al Seeb	56	34	24 (48.97)
Bawsher	22	11	10 (20.41)
Mutrah	19	9	5 (10.20)
Qurayyat	22	6	4 (8.16)
Al Amerat	22	6	3 (6.12)
Muscat	12	4	3 (6.12)
Total	153	70	49

*Number of schools in 2016 according to the National Information and Statistics Centre

**Number of school nurses who participated in the survey

7.2.2 School Nurses' Roles and Functions

The top nursing activities reported by the majority of school nurses were first aid (81.63%, n = 40), administration of immunization (79.59%, n = 39), individual health teaching (71.43%, n = 35) and medication administration (71.43%, n = 35). The most commonly identified asthma-related roles and functions of school nurses in the school setting were educating students about

asthma management and exacerbation prevention (n = 32) and medication and delivery devices (n = 29). While 40.82% (n = 20) of school nurses reported educating parents regarding asthma management or attack prevention, only five school nurses (10.2%) educated parents about medication and medication delivery devices. The number of school nurses who stated that one of their roles was to educate teachers about medication and delivery devices was 15 (Table 7.3).

Table 7.3. Types of Activities Performed by School Nurses in a School Setting

Item	Type	*n*	%
1	First aid	40	81.63%
2	Immunization administration	39	79.59%
3	Individual health teaching	35	71.43%
4	Medication administration	35	71.43%
5	Classroom teaching	34	69.39%
6	School-wide wellness promotion	34	69.39%
7	Contacting of parents to collect a sick child	34	69.39%
8	Support groups	33	67.35%
9	Education of students on asthma management or exacerbation prevention	32	65.31%
10	Transport of sick child to home or emergency department	31	63.27%
11	Education of students on the use of asthma medication delivery devices	29	59.18%
12	Development of emergency plans	27	55.10%
13	Development of classroom modifications for students with health problems	25	51%
14	Education of teachers on asthma management or attack prevention	24	48.98%
15	Development of a fire evacuation plan for impaired students	22	44.90%
16	Education of parents on asthma management or attack prevention	20	40.82%
17	Individualized health plan development/implementation	17	34.70%
18	Education of teachers on the use of asthma medication delivery devices	15	30.61%
19	In-service presentations for staff	14	28.57%
20	In-service presentations for family	9	18.37%
21	Education of parents on the use of asthma medication delivery devices	5	10.20%
	Other (please specify)		
22	Assessment of playfield	2	4.1%
23	Drinking water safety check-up	2	4.1%
24	Cafeteria check-up and assessment	3	6.1%
25	Arrangement of health-related roleplay performances in front of an audience	3	6.1%

7.2.3 Medication Administration Policy

More than half of school nurses (55.1%, *n* = 27) reported that their school region had a medication administration policy, whereas 30.6% (*n* = 15) were not sure whether one existed. Twenty-three school nurses (46.9%) reported that students were permitted to self-administer their oral asthma medication. However, more than half of the school nurses (53.1%, *n* = 26) reported that students were not permitted to do so. The majority of school nurses (87.8%, *n* = 43) believed that students were permitted to have their inhaled medication self-administered at school, whereas 12.2% (*n* = 6) responded that students were not permitted to do so (Table 7.4). Most respondents (83.7%, *n = 41*) supervise students who are self-administering asthma medication, while eight (16.3 %) do not.

Table 7.4. Response of School Nurses Regarding Whether Students Are Permitted to Self-Administer Asthma Prescription Medication and Other Medication

Type	(N =Yes Responses; %)
Self-administered asthma prescription	
Oral asthma medication	23 (46.9)
Inhaled asthma medication	43 (87.8)
Self-administered non-asthma prescription	
Oral non-asthma medication	24 (49.0)
Inhaled non-asthma medication	35 (71.4)
Epi-pen medication	11 (22.4)
Insulin injection	23 (46.9)

In response to the question "*Are students permitted to self-administer non-asthma medication prescription?*" 49% (n = 24) of school nurses reported that students were permitted to self-administer oral non-asthma medication, with 71.4% (*n* = 35) indicating that students were permitted to self-administer inhaled non-asthma medication. Furthermore, whereas most school nurses (77.6%, *n* = 38) noted that students were not allowed to self-administer Epi-pen medication, 22.4% (n = 11) stated that students were permitted do so. More than half of the respondents (53.1%, *n* = 26) also reported that students were not permitted to self-administer insulin injections, whereas 46.9% (*n* = 23) agreed that it may be self-administered by students (Table 7.4). Most respondents (73.5%, *n = 36*) reported that pharmacy labels were the only accepted labels in schools, whereas 26.5% (*n* = 13) reported that their schools accepted both pharmacy and parent labels.

7.2.4 School Nurses' Role in Delegating Nursing Actions to Unlicensed Personnel

The majority of school nurses (67.3%; *n* = 33) did not delegate nursing actions to unlicensed personnel such as schoolteachers. Moreover, 65.3% (*n* = 32) of school nurses did not have a health assistant.

7.2.5 Exacerbation Management

Sixty-nine per cent *(n=34)* of school nurses reported that asthma-related medical emergencies were managed by the registered nurse, followed by the parent liaison (12.2%, *n* = 6). Five school nurses also identified the school principal as a person who could take care of an asthma-related emergency.

Overall, nine (18.4%) school nurses in the Muscat Governorate estimated that they encountered students with an asthma exacerbation at least 2–3 times a week, with 11 (22.4%) nurses reporting a frequency of once a week. In contrast, 26.5% (*n* =13) and 12.2% (*n* = 6) of school nurses reported that an asthma attack occurred once a month and once every other month, respectively. Only three school nurses reported having never seen students with asthma in a school setting.

The student health record was the document that most school nurses (71.4%, *n* = 35) used to record an asthma episode. Sending a letter to parents with a copy of that letter placed in the school health records was reported by 12 nurses (24.5%). One respondent (2.0%) indicated that asthma episodes are documented in student health records and principal records. Added to this, all teachers who deal with the child should be informed about the student health condition, and a health card with their details should be issued for the students to show when needed as an evidence of their condition.

7.2.6 Education and Training

More than half of school nurses (55%, *n* = 27) reported that no asthma-related educational training was offered in their schools, with just under half (44.9%, *n* = 22) indicating that such training programmes were available in their schools. The results revealed that 55.1% (*n* = 27) and 18.4% (*n* = 9) of school nurses attended an asthma education programme either over a year ago or in the past year. Nearly a quarter of nurses (20.4%, n = 10) never attended such programmes. More importantly, of those school nurses who never attended an asthma programme, four (8.16%) encountered a student once a month with an asthma exacerbation, and another four (8.16%) reported that they did not have age-appropriate asthma educational materials. In addition, of those who had attended an asthma education training programme more than a year ago, eight (16.33%) encountered a student once a week with an asthma exacerbation, and five (10.20%) encountered a student with asthma exacerbation 2–3 times a week. Overall, most school nurses (57.1%, n = 28) reported that they do not have any asthma-related educational materials in their schools.

The top topics school nurses listed as essential issues in an asthma education programme were as follows:

(1) Current asthma guidelines (*n* = 9)

(2) Medication administration and medication delivery devices (*n* = 8)

(3) Age-appropriate teaching materials (*n* = 8)

(4) Assessment and monitoring (*n* = 4)

(5) Exacerbation management (*n* = 3)

(6) Inter-professional collaboration in asthma management in schools (*n* = 3)

(7) Asthma management in a school setting (*n* = 2)

8) Other: trigger prevention and environmental control (n = 1), management of students with asthma during the COVID-19 pandemic (n = 1) and asthma treatment (n = 1)

7.2.7 Use of a Peak Flow Meter

Only five (10.2%) school nurses reported the use of a peak flow meter (PFM) when assessing children with asthma. Of those, two (4.08%) attended an asthma education programme in the past year, and four (8.16%) reported that they encountered a student with asthma either daily (n = 1, 2.04%), 2–3 times a week (n = 2, 4.08%), or once a week (n = 1, 2.04%). It is interesting to note that that 10 (27.77%) school nurses who reported attending an asthma education programme in the past year did not use a PFM to monitor asthma. The majority of school nurses (89.8%, n = 44) reported that they did not use a PFM to assess asthma in the school setting, including nurses who encountered a student with asthma exacerbation daily (4.08%, n = 2), 2–3 times a week (14.29%, n = 7) or once a week (n = 10; 20.41%).

7.2.8 School Nurse Association Membership and the Use of Asthma Guidelines

None of the school nurses were members of any school nurse association. The majority of school nurses (83.7%; n = 41) did not use asthma guidelines when caring for students with asthma. Of those school nurses (16.3%, n = 8) who use asthma guidelines, five reported using the Ministry of Health asthma guidelines, with two following the Glasgow Medicine Guidelines when managing asthma at schools.

It should be noted that there was no correlation between the demographics of school nurses (age, years of experience in nursing, years of experience in school nursing, level of education) and the performance of some asthma care activities, including delegating nursing actions to unlicensed personnel, use of PFM to monitor asthma, attending asthma educational programmes and the use of asthma guidelines when providing care for students with asthma. Table 7.5 shows the results of the Spearman correlation analysis.

Table 7.5. Correlation Between Demographic and Performance of Some Asthma Care Activities

Item		Age	Years of experience in nursing	Years of experience in school nursing	Level of Education	Community Health Qualification
Delegating nursing actions to unlicensed personnel is part of my role.	Correlation Coefficient	.229	.229	-.059	-.062	.076
	Sig. (2-tailed)	.114	.114	.689	.674	. .602
Do you use a peak flow meter when assessing children?	Correlation Coefficient	.069	.069	.115	.114	.271
	Sig. (2-tailed)	.636	.636	.432	.437	.059
Have you attended any asthma education programme?	Correlation Coefficient	.113	.113	.085	-.074	-.165
	Sig. (2-tailed)	.438	.438	.564	.615	.256
Do you use any asthma guidelines in your school?	Correlation Coefficient	-.008	.008	.114	-.208	-.091
	Sig. (2-tailed)	.957	.957	.436	.151	.533
*Correlation is significant at the 0.05 level (2-tailed).						

7.3 Phase 2: Asthma Education Programme for School Nurses in Muscat Government Schools

Phase 2 aims to assess the impact of SNAEP on school nurses' asthma knowledge and self-efficacy levels. Four data collection times were used for the assessment. Time 1 refers to the school nurses' asthma knowledge level before receiving SNAEP, time 2 refers to the school nurses' asthma knowledge level immediately after SNAEP, time 3 refers to the school nurses' asthma knowledge level three months after SNAEP and time 4 refers to the school nurses' asthma knowledge level six months after receiving SNAEP.

7.3.1 Response and Demographics

As part of this study, all school nurses in Al Seeb and Bawsher Counties ($N = 45$) were invited to participate in the SNAEP educational intervention. Five nurses reported that they were

processing their retirement plan. The total number of school nurses in these two counties in was 45 (males and females) January 2021. Owing to COVID-19 restrictions and Ministry of Health (MOH) gathering guidelines, the programme was conducted over two days with 23 nurses attending on day one and 17 nurses attended on day two. Restrictions in attendance are described in Chapter 4, Sections 4.6.3 and 4.6.6. In total, 40 nurses attended the programme, consented, and returned the surveys at Time 1, which took place prior to receiving SNAEP on 22-23 February 2021. At Time 2, immediately following the delivery of the intervention, 36 school nurses returned the surveys, at Time 3, three months post intervention, 39 school nurses returned the completed survey, and 37 school nurses returned the completed surveys at Time 4, six months post intervention. A total of 36 school nurses completed all time points of the study.

The nurses' ages ranged from 31 to 46 years old, with only one participant who was 60 years old. The educational level for 31 (86.11%) and fours (11.11%) school nurses was a diploma and bachelor's degree in nursing, respectively. Table 7.6 shows the demographic distribution of participants.

Table 7.6. Demographics of Survey Participants

Age (years)	Frequency	Percentage
30–34	8	22.22%
35–39	17	47.22%
40–44	7	19.44%
45–49	3	8.33%
60–64	1	2.77%
Mean Age (SD*)	37.5 (5.43) years	
Educational level	Frequency	Percentage
Diploma in nursing	31	86.11%
Bachelor's degree in nursing	4	11.11%
Other	1	2.7%
Years of nursing experience	Frequency	Percentage
6–10	4	11.11%
11–15	14	38.88%
16–20	14	38.88%
21–25	3	8.33%
31–35	1	2.77%
Mean (SD)	16.30 (4.85) years	
Years of Experience in School Nursing	Frequency	Percentage
1–5	14	38.88%
6–10	18	50.00%
11–15	2	5.55%
16–20	1	2.77%
31–35	1	2.77%
Mean (SD)	7.19 (5.91) years	

7.3.2 Overall Knowledge Scores

The overall mean knowledge score across all time points was 38.88 (SD 2.967), with scores ranging from a minimum score of 35 to a maximum score of 44 (Table 7.7).

Table 7.7. School Nurses' Asthma Knowledge at Times 1, 2, 3, and 4

	Time 1 (*N* = 36)	**Time 2 (*N* = 36)**	**Time 3 (*N* = 36)**	**Time 4 (*N* = 36)**	**Overall**
% Correct Responses	44.6	86.8	82.1	75.5	
Minimum Score	29	35	35	35	
Maximum Score	37	41	43	44	
Mean Score	34.08	37.33	38.97	38.67	37.65
(SD)	(2.15)	(1.724)	(1.71)	(2.111)	(2.90)

7.3.3 Asthma Knowledge Score at Times 1, 2, 3 and 4

7.3.3.1 School nurses' knowledge level at Time 1 (prior to SNAEP)

The overall percentage of correct responses was 44.6%, with a mean score of 34.08. The knowledge items with the most correct responses were items related to asthma disease as chronic airway inflammation and that the only way to control it is through trigger avoidance and medication compliance. For example, 32 (88.88%) school nurses answered item 11 correctly: "*People with asthma can usually control their symptoms by taking medicine and avoiding things that make their asthma worse*", and 30 (83.3%) nurses answered item 14 correctly: "*Untreated asthma can cause death"*. The majority of school nurses were able to identify that asthma is not a psychological or emotional disease (80.6%, *n* = 29).

Items with the least correct responses were those related to the use of medication and medication delivery devices. For example, five nurses answered item 1 correctly: "*Peak flow meters are used to determine if someone has asthma"*, and only three nurses (8.3%) answered item 23 correctly: "*It may take 1-4 weeks to notice improvement in breathing when the child with asthma starts using inhaled steroid medication*". One question about the classification of asthma according to the recent asthma guidelines was incorrectly answered by the majority (91.66%, *n* = 33). Similarly, only three school nurses (8.3%) identified that asthma can get worse without a noticeable change in breathing. Table **7.8** presents school nurses' asthma knowledge questionnaire responses at Time 1 from items with the most correct responses to items with the least correct responses.

Table 7.8. School Nurses' Responses to the Asthma Knowledge Questionnaire at Time 1

School Nurses' Responses to the Asthma Knowledge Questionnaire before SNAEP	
Item	N* (%)
People with asthma can usually control their symptoms by taking medicine and avoiding things that make their asthma worse.	32(88.9)
Untreated asthma can cause death.	30 (83.3)
Fish and birds are both good pets for a child with asthma.	30 (83.3)
Asthma is an emotional disease.	29 (80.6)
Children with asthma should not participate in activities where they run a lot.	29 (80.6)
Asthma, regardless of its severity, is a chronic inflammatory disorder of airways. .	28 (77.8)
Children with asthma do not need to take medicine if they feel normal.	28 (83.3)
An early warning sign of asthma may be a chronic cough, especially at night.	27 (75.0)
Keeping the bedroom windows open at night will help prevent asthma symptoms.	26 (72.2)
A child with asthma whose age is from 5-11 years old who needs to use a rescue inhaler two times a week and oral steroids once a year is considered well controlled.	15 (41.7)
A child with asthma with a peak flow reading of 85% is considered in the yellow zone and should initiate their asthma action plan.	15 (41.7)
A rescue inhaler (i.e., bronchodilator) is taken to reduce the inflammation in the lungs.	13 (36.1)
Airway inflammation is present in almost all children with asthma, even when asthma symptoms are well-controlled.	13 (36.1)
When using a dry powder inhaler, the powder needs to be inhaled by taking a slow and deep breath.	12 (33.3)
If asthma symptoms such as tightness or wheezing do not occur for several years, a child has outgrown his/her asthma.	12 (33.3)
Children with asthma can be cured with medication.	10 (72.8)
Uncontrolled asthma can impair lung growth in children.	6 (16.7)
Children should use a spacer or valved holding chamber when taking their dry powder inhalers.	6 (16.7)

School Nurses' Responses to the Asthma Knowledge Questionnaire before SNAEP

Item	N* (%)
Peak flow meters are used to determine if someone has asthma.	5(13.9)
The purpose of steroid medication inhalers is to stop an asthma attack when it occurs.	5 (13.9)
After taking a quick acting inhaler, the child should hold his/her breath for 10 seconds after each puff and wait one minute between puffs.	5 (13.9)
It is possible for your asthma to be worse without noticing a change in your breathing.	3 (8.3)
It may take 1-4 weeks to notice improvement in breathing when the child with asthma starts using inhaled steroid medication.	3 (8.3)
The four classifications of asthma according to the most recent asthma guidelines are: mild intermittent, mild persistent, moderate persistent and severe persistent.	3 (8.3)

7.3.3.2 School nurses' knowledge level at Time 2 (immediately after SNAEP)

Immediately post intervention, the overall percentage of correct responses increased to 86.6%, with a mean asthma knowledge score of 37.33. Items related to asthma disease as chronic airway inflammation remained among the most correctly answered questions. All respondents ($N = 36$) agreed that medication adherence and trigger prevention keep asthma under control. In addition, for the item stating, "*If asthma symptoms such as tightness or wheezing do not occur for several years, a child has outgrown his/her asthma"*, all school nurses provided the correct answer. Almost all school nurses (97.2%, $n = 35$) recognized that a spacer should not be used with a dry powder inhaler.

The items with the least correct responses were items related to medication administration and the use of PFM. Less than half of school nurses (44.4%, $n = 16$) recognised the purpose of a steroid inhaler as a long-term controller medication for children with asthma, and only 21 (58.3%) recognised the use of bronchodilators in reducing lung inflammation. The second-least correct response was related to the use of PFM. There were 16 (44.4%) school nurses who still perceived PFM as an asthma diagnostic method compared to 31 (86.11%) in Time 1.

There are some items in Time 2 that show a noticeable improvement from Time 1. The majority of school nurses (94.44%, n = 34) recognised the use of steroids in asthma exacerbation, 31 more than in Time 1 (8.3%, $n = 3$). While in Time 1, few nurses (33.3%, $n = 12$) were aware that when using a dry powder inhaler, one should inhale the powder by taking a slow and deep breath, the majority of nurses (97.22%, $n = 35$) demonstrated a correct dry powder inhaler technique in Time 2. In addition, the number of school nurses who were aware that a spacer should not be used with a dry powder inhaler increased from six (16.7%) to 35 (97.22%). Twenty-nine school nurses (80.6%) were able to recognize that asthma could get worse without a noticeable change in breathing compared to three (8.3%) in Time 1. For the question regarding "*whether children with asthma can play sports in which they run a lot"*, 30 (83.33%) nurses answered correctly compared to 17 (47.2%) at Time 1. The majority of school nurses ($n = 32$, 88.9%) were able to recognize that fish and birds are not ideal pets for children with asthma, compared with 23 (63.9%) at Time 1. Table **7.9** presents school nurses' asthma knowledge

questionnaire responses at Time 2 starting from items with the most correct responses to items with the least correct responses.

Table 7.9. School Nurses' Responses to the Asthma Knowledge Questionnaire at Time 2

School Nurses' Responses to the Asthma Knowledge Questionnaire Immediately after SNAEP	
Item	N* (%)
People with asthma can usually control their symptoms by taking medicine and avoiding things that make their asthma worse.	36 (100)
Untreated asthma can cause death.	36 (100)
Asthma is an emotional disease.	36 (100)
If asthma symptoms such as tightness or wheezing do not occur for several years, a child has outgrown his/her asthma.	36 (100)
Children with asthma do not need to take medicine if they feel normal.	35 (97.2)
The four classifications of asthma according to the most recent asthma guidelines are: mild intermittent, mild persistent, moderate persistent and severe persistent. .	35 (97.2)
Children should use a spacer or valved holding chamber when taking their dry powder inhalers.	35 (97.2)
Asthma, regardless of its severity, is a chronic inflammatory disorder of the airways.	35 (97.2)
When using a dry powder inhaler, the powder needs to be inhaled by taking a slow and deep breath.	35 (97.2)
Uncontrolled asthma can impair lung growth in children.	34 (94.4)
It may take 1-4 weeks to notice improvement in breathing when the child with asthma starts using inhaled steroid medication.	34 (94.4)
Children with asthma can be cured with medication.	33 (91.7)
An early warning sign of asthma is a chronic cough, especially at night.	33 (91.7)
Keeping your bedroom windows open at night will help prevent asthma symptoms.	33 (91.7)
After taking a quick acting inhaler, the child should hold his/her breath for 10 seconds after each puff and wait one minute between puffs.	33 (91.7)
Fish and birds are both good pets for a child with asthma.	32 (88.9)
Children with asthma should not play sports in which they run a lot.	30 (83.3)

School Nurses' Responses to the Asthma Knowledge Questionnaire Immediately after SNAEP

Item	N* (%)
It is possible for a child's asthma to be worse without noticing a change in their breathing.	29 (80.6)
A child with asthma whose age is from 5-11 years old who needs to use a rescue inhaler two times a week and oral steroids once a year is considered well controlled.	28 (77.8)
Airway inflammation is present in almost all children with asthma, even when asthma symptoms are well-controlled.	28 (77.8)
A child with asthma with a peak flow reading of 85% is considered in the yellow zone and should initiate their asthma action plan.	25 (69.4)
A rescue inhaler (i.e., bronchodilator) is taken to reduce the inflammation in the lungs.	21 (58.3)
Peak flow meters are used to determine if someone has asthma	20 (55.6)
The purpose of steroid medication inhalers is to stop an asthma attack when it occurs.	16 (44.4)

7.3.3.3 School nurses' knowledge level at Time 3 (three months after SNAEP)

The percentage of correct responses was 82.1% lower than at Time 2; however, the mean asthma knowledge score was 38.97, the highest mean score among the four data collection time points. Similar to Time 2, the most correctly answered items for Time 3 were those related to asthma as a chronic condition and trigger avoidance and medication compliance as the only way to control it. These items were: "*People with asthma can usually control their symptoms by taking medicine and avoiding things that make their asthma worse*", "*Asthma is an emotional disease*" and "*Children with asthma do not need to take medicine if they feel normal*".

The item with the least correct responses was: "*A child with asthma with a peak flow reading of 85% is considered in the yellow zone and should initiate their asthma action plan"* with only 10 (27.8%) school nurses classifying a child with a PFM reading of 85% as being in the green zone. The second item with the least correct response was "*The purpose of steroid medication inhalers is to stop an asthma attack when it occurs*", with only 13 (36.1%) school nurses recognising the purpose of steroid inhalers as long-term controller medications for children with asthma. This item was the most incorrectly answered question in Time 2 as well, with only 16 (44.4%) correct responses. Knowledge regarding the use of a dry powder inhaler and quick-acting inhaler was maintained with 35 (97.2%) and 36 (100%) correct responses, respectively. Table 7.10 presents school nurses' asthma knowledge questionnaire responses Time 3 starting from items with the most correct responses to items with the least correct responses.

Table 7.10. School Nurses' Responses to the Asthma Knowledge Questionnaire at Time 3

School Nurses' Responses to the Asthma Knowledge Questionnaire Three Months after SNAEP	
Item	N* (%)
People with asthma can usually control their symptoms by taking medicine and avoiding things that make their asthma worse.	36 (100)
Asthma is an emotional disease.	36 (100)
Children with asthma do not need to take medicine if they feel normal.	36 (100)
After taking a quick acting inhaler, the child should hold his/her breath for 10 seconds after each puff and wait one minute between puffs.	36 (100)
The four classifications of asthma according to the most recent asthma guidelines are: mild intermittent, mild persistent, moderate persistent and severe persistent. .	35 (97.2)
When using a dry powder inhaler, the powder needs to be inhaled by taking a slow and deep breath.	35 (97.2)
Asthma, regardless of its severity, is a chronic inflammatory disorder of the airways.	34 (94.4)
If asthma symptoms such as tightness or wheezing do not occur for several years, a child has outgrown his/her asthma.	34 (94.4)
Untreated asthma can cause death.	34 (94.4)
An early warning sign of asthma is a chronic cough, especially at night.	34 (94.4)
It may take 1-4 weeks to notice improvement in breathing when the child with asthma starts using inhaled steroid medication.	34 (94.4)
Uncontrolled asthma can impair lung growth in children.	33 (91.7)
Children with asthma should not play sports in which they run a lot.	33 (88.9)
Fish and birds are both good pets for a child with asthma.	30 (83.3)
Airway inflammation is present in almost all children with asthma, even when asthma symptoms are well-controlled. It is possible for children's asthma to become worse without noticing a change in their breathing.	31 (86.1)
Keeping your bedroom windows open at night will help prevent asthma symptoms.	29 (80.6)
Children with asthma can be cured with medication.	27 (75)
Children should use a spacer or valved holding chamber when taking their dry powder inhalers.	26 (72.2)
It is possible for children's asthma to become worse without noticing a change in their breathing.	26 (72.2)

School Nurses' Responses to the Asthma Knowledge Questionnaire Three Months after SNAEP

Item	N* (%)
A rescue inhaler (i.e., bronchodilator) is taken to reduce the inflammation in the lungs.	25 (69.4)
Peak flow meters are used to determine if someone has asthma.	20 (55.6)
A child with asthma whose age is from 5-11 years who needs to use a rescue inhaler two times a week and oral steroids once a year is considered well controlled.	20 (55.6)
The purpose of steroid medication inhalers is to stop an asthma attack when it occurs.	13 (36.1)
A child with asthma with a peak flow reading of 85% is considered in the yellow zone and should initiate their asthma action plan.	10 (27.8)

7.3.3.4 School nurses' knowledge level at time 4 (six months after SNAEP)

The mean asthma knowledge score in Time 4 was 38.66 lower than at Time 3, with an overall percentage of 75.2% correct responses. Items with the most correct responses were the same exact items as those in Times 2 and 3. These items were related to asthma being a chronic condition that could cause death if uncontrolled, and children's ability to control their asthma by medication compliance and trigger avoidance. Knowledge regarding the use of a dry powder inhaler remained the same as Times 2 and 3, with 35 (97.2%) school nurses answering this item correctly. There were some items that show a knowledge reduction from Time 3. For instance, 25 (69.4%) school nurses recalled that the absence of asthma symptoms for several years does not reflect that a child has outgrown their asthma, compared to 34 (94.4%) in Time 3. School nurses with knowledge regarding quick acting inhaler use reduced from 35 (97.2%) in Time 3 to 33 (91.7%) in Time 4. The number of school nurses who recognised that a spacer should not be used with a dry powder inhaler decreased from 26 (72.2%) in Time 3 to 21 (58.3%) in Time 4.

Items with the least correct responses in Time 4 were also related to medication use as well as classifying a child's asthma based on their medication use. Thirteen (36.1%) school nurses recognised the use of bronchodilators to relax the airways compared with 25 (69.4%) at Time

3. Seventeen (47.2%) school nurses correctly classified a child's asthma as uncontrolled when they needed to use a rescue inhaler twice a week and oral steroids once a year. Table 7.11 presents school nurses' asthma knowledge questionnaire responses at Time 4 starting from items with the most correct responses to items with the least correct responses.

Table 7.11. School Nurses' Responses to Asthma Knowledge Questionnaire at Time 4

School Nurses' Responses to the Asthma Knowledge Questionnaire Six Months after SNAEP	
Item	N* (%)
People with asthma can usually control their symptoms by taking medicine and avoiding things that make their asthma worse.	36 (100)
Untreated asthma can cause death.	36 (100)
Asthma is an emotional disease.	36 (100)
Asthma, regardless of its severity, is a chronic inflammatory disorder of the airways.	35 (97.2)
When using a dry powder inhaler, the powder needs to be inhaled by taking a slow and deep breath.	35 (97.2)
The four classifications of asthma according to the most recent asthma guidelines are: mild intermittent, mild persistent, moderate persistent and severe persistent.	34 (94.4)
After taking a quick acting inhaler, the child should hold his/her breath for 10 seconds after each puff and wait one minute between puffs.	33 (91.7)
It may take 1-4 weeks to notice improvement in your breathing when you start using inhaled steroid medication.	33 (91.7)
An early warning sign of asthma is a chronic cough, especially at night.	31 (86.1)
Uncontrolled asthma can impair lung growth in children.	31 (86.1))
Children with asthma do not need to take medicine if they feel normal.	29 (80.6)
Keeping your bedroom windows open at night will help prevent asthma symptoms.	29 (80.6)
Fish and birds are both good pets for a child with asthma.	28 (77.8)
Children with asthma should not play sports in which they run a lot.	27 (75)
A child with asthma with a peak flow reading of 85% is considered in the yellow zone and should initiate their asthma action plan.	26 (72.2)
If asthma symptoms such as tightness or wheezing do not occur for several years, a child has outgrown his/her asthma.	25 (69.4)
It is possible for children's asthma to become worse without noticing a change in their breathing.	24 (66.7)

School Nurses' Responses to the Asthma Knowledge Questionnaire Six Months after SNAEP	
Item	N* (%)
Children with asthma can be cured with medication.	22 (61.1)
Airway inflammation is present in almost all children with asthma, even when asthma symptoms are well-controlled.	20 (55.6)
Children should use a spacer or valved holding chamber when taking their dry powder inhalers.	18 (50)
A child with asthma whose age is from 5-11 years old who needs to use a rescue inhaler two times a week and oral steroids once a year is considered well controlled.	17 (47.2)
The purpose of steroid medication inhalers is to stop an asthma attack when it occurs.	17 (47.2)
Peak flow meters are used to determine if someone has asthma	15 (41.7)
A rescue inhaler (i.e., bronchodilator) is taken to reduce inflammation in the lungs.	13 (36.1)

Table 7.12 shows mean, SD and the percentage of correct responses to the 24-item asthma knowledge questionnaire at the four data collection time points.

Table 7.12. The Mean, Standard Deviation (SD) and, Percentage of Correct Responses to the 24-Item Asthma Knowledge Questionnaire

		Time (1)		Time (2)		Time (3)		Time (4)	
	Item	N* (%)	Mean (SD)	N*(%)	Mean (SD)	N*(%)	Mean (SD)	N* (%)	Mean (SD)
1	Peak flow meters are used to determine if someone has asthma.	5 (13.9)	1.86 (0.35)	20(55.6)	1.44 (0.50)	20(55.6)	1.44 (0.50)	15(41.7)	1.58 (0.50)
2	Uncontrolled asthma can impair lung growth in children.	6 (16.7)	1.17 (0.37)	34(94.4)	1.94 (0.23)	33(91.7)	1.92 (0.28)	31(86.1)	1.86 (0.35)
3	The four classifications		1.08 (0.28)	35(97.2)	1.97 (0.17)	35(97.2)	1.97 (0.17)	34(94.4)	1.94 (0.23)

		Time (1)		Time (2)		Time (3)		Time (4)	
	Item	N* (%)	Mean (SD)	N*(%)	Mean (SD)	N*(%)	Mean (SD)	N* (%)	Mean (SD)
	of asthma according to the most recent asthma guidelines are: mild intermittent, mild persistent, moderate persistent and severe persistent.	3 (8.3)							
4	A child who has asthma whose age is from 5-11 years old who needs to use a rescue inhaler two times a week and oral steroids once a year is considered well controlled.	15(41.7)	1.58 (0.50)	28(77.8)	1.22 (0.42)	20(55.6)	1.44 (0.50)	17(47.2)	1.53 (0.51)
5	A child with asthma with a peak flow reading of 85% is considered in the yellow zone and should initiate their asthma action plan.	15(41.7)	1.58 (0.50)	25(69.4)	1.31 (0.47)	10(27.8)	1.72 (0.45)	26(72.2)	1.28 (0.45)
6	Children should use a spacer or valved holding chamber when taking their dry powder inhalers.	6 (16.7)	1.83 (0.38)	35(97.2)	1.03 (0.17)	26(72.2)	1.28 (0.45)	18(50.0)	1.50 (0.51)
7	Asthma is an emotional disease.	29(80.6)	1.81 (0.40)	36(100)	1.00 (0.00)	36(100)	1.00 (0.00)	36(100)	1.00 (0.00)
8	Asthma, regardless of its severity, is a	28(77.8)	1.78 (0.42)	35(97.2)	1.97 (0.17)	34(94.4)	1.94 (0.23)	35(97.2)	1.97 (0.17)

		Time (1)		Time (2)		Time (3)		Time (4)	
	Item	N* (%)	Mean (SD)	N*(%)	Mean (SD)	N*(%)	Mean (SD)	N* (%)	Mean (SD)
	chronic inflammatory disorder of the airways.								
9	If asthma symptoms such as tightness or wheezing do not occur for several years, a child has outgrown his/her asthma.	12(33.3)	1.67 (0.48)	36(100)	1.00 (0.00)	34(94.4)	1.94 (0.232)	25(69.4)	1.31(0.47)
10	Airway inflammation is present in almost all children with asthma, even when asthma symptoms are well-controlled.	13(36.1)	1.36 (0.48)	28(77.8)	1.78 (0.42)	31(86.1)	1.86 (0.35)	20(55.6)	1.56(0.50)
11	People with asthma can usually control their symptoms by taking medicine and avoiding things that make their asthma worse.	32(88.9)	1.89 (0.32)	36(100)	2.00 (0.00)	36(100)	2.00 (0.00)	36(100)	2.00(0.00)
12	Children with asthma can be cured with medication.	10(27.8)	1.72 (0.45)	33(91.7)	1.08 (0.28)	27(75.0)	1.25 (0.44)	22(61.1)	1.39(0.49)
13	It is possible for your asthma to become worse without noticing a change in breathing.	3 (8.3)	1.08 (0.28)	29(80.6)	1.81 (0.40)	26(72.2)	1.72 (0.45)	24(66.7)	1.67(0.47)
14	Untreated asthma can cause death.	30(83.3)	1.83 (0.38)	36(100)	2.00 (0.00)	34(94.4)	1.94 (0.23)	36(100)	2.00(0.00)
15	An early warning sign of asthma may be a chronic	27(75.0)	1.75 (0.43)	33(91.7)	1.92(0.28)	34(94.4)	1.94 (0.23)	31(86.1)	1.86(0.35)

		Time (1)		Time (2)		Time (3)		Time (4)	
	Item	N* (%)	Mean (SD)	N*(%)	Mean (SD)	N*(%)	Mean (SD)	N* (%)	Mean (SD)
	cough, especially at night.								
16	Children with asthma should not participate in activities where they run a lot.	29(80.6)	1.81 (0.40)	30(83.3)	1.83 (0.38)	33(91.7)	1.92(0.28)	27(75.0)	1.75(0.44)
17	Fish and birds are both good pets for a child with asthma.	30(83.3)	1.17 (0.38)	32(88.9)	1.22 (0.422)	32(88.9)	1.11 (0.32)	28(77.8)	1.22(0.42)
18	Keeping the bedroom windows open at night will help prevent asthma symptoms.	26(72.2)	1.28 (0.45)	33(91.7)	1.08 (0.28)	29(80.6)	1.19(0.40)	29(80.6)	1.08(0.28)
19	A rescue inhaler (i.e., bronchodilator) is taken to reduce inflammation in the lungs.	13(36.1)	1.64 (0.49)	21(58.3)	1.42 (0.50)	25(69.4)	1.31(0.47)	13(36.1)	1.64(0.49)
20	The purpose of steroid medication inhalers is to stop an asthma attack when it occurs.	5 (13.9)	1.86 (0.35)	16(44.4)	1.56 (0.50)	13(36.1)	1.64(0.48)	17(47.2)	1.53(0.51)
21	Children with asthma do not need to take medicine if they feel normal.	28(83.3)	1.22 (0.42)	35(97.2)	1.03 (0.17)	36 (100)	1.00(0.00)	29(80.6)	1.19(0.40)
22	It may take 1-4 weeks to notice improvement in breathing when a child with asthma starts using an inhaled steroid medication.	3 (8.3)	1.08 (0.28)	34(94.4)	1.94 (0.23)	34 (94.4)	1.94(0.23)	33(91.7)	1.92(0.28)

		Time (1)		Time (2)		Time (3)		Time (4)	
	Item	N* (%)	Mean (SD)	N*(%)	Mean (SD)	N*(%)	Mean (SD)	N* (%)	Mean (SD)
23	When using a dry powder inhaler, the powder needs to be inhaled by taking a slow and deep breath.	12(33.3)	1.33 (0.48)	35(97.2)	1.97 (0.17)	35(97.2)	1.97(0.17)	35(97.2)	1.97(0.17)
24	After taking a quick acting inhaler, the child should hold his/her breath for 10 seconds after each puff and wait one minute between puffs.	5 (13.9)	1.14 (0.35)	33(91.7)	1.92 (0.28)	36(100)	2.00(0.00)	33(91.7)	1.92(0.28)
	Overall	44.6%	1.48 (0.17)	86.6%	1.56 (0.07)	82.1%	1.62 (0.07)	75.2%	1.60 (0.09)

*N** = the number and percentage of participants who provided a correct response to this statement.

7.3.4 Comparison Between School Nurses' Asthma Knowledge Scores at Time 1 and Time 2 Using a Paired Sample t-test

The mean asthma knowledge score was 1.48 (*SD* = 0.17) at Time 1 and 1.56 (*SD* = 0.07) at Time 2. These data were compared using a paired sample t-test, which revealed a significant difference in asthma knowledge before and immediately after the programme. On average, school nurses showed statically significant asthma knowledge gain at Time 2 compared to Time 1: t (36) = 2.118; p = .041; effect size [d] = 0.4.

7.3.5 Comparison Between School Nurses' Asthma Knowledge Scores at Time 1 and Time 2 Using the Wilcoxon Signed-Rank Test

The Wilcoxon signed-rank test revealed a statistically significant difference between the participants' pre-test scores (Time 1) and post-test scores (Time 2; Z = -2.12, p = .03; effect size [r] =. 0.35).

7.3.6 Comparison Between School Nurses' Asthma Knowledge Scores at Time 1 and Time 3

The mean asthma knowledge scores at Time 1 and Time 3 were (M = 1.48, SD = 0.17) and (M = 1.62, SD = 0.07), respectively. A comparison of the means revealed some differences. The paired sample t-test showed that school nurses' asthma knowledge scores were higher in Time 3 compared to Time 1. The difference was statistically significant: t (35) = 5.37, p = .000, effect size [d] = 0.89.

7.3.7 Comparison Between School Nurses' Asthma Knowledge Scores at Time 1 and Time 4

A paired sample t-test showed that school nurses scored significantly higher on asthma knowledge at Time 4 (M = 1.60, SD = 0.09) compared with Time 1 (M = 1.48, SD = 0.17), t (35)= 4.37, p = .000; effect size [d] = 0.73.

7.3.8 Comparison Between School Nurses' Asthma Knowledge Scores at Time 2 and Time 3

The results of the paired sample t-test revealed that school nurses had a significantly higher mean knowledge score at Time 3 (M = 1.62, SD = 0.07) compared with Time 2 (M = 1.56, SD = 0.07); t (35) = 3.47; p = .000; effect size [d] = 0.70.

7.3.9 Comparison Between School Nurses' Asthma Knowledge Scores at Time 2 and Time 4

The results of the paired sample t-test showed that school nurses had a higher asthma mean knowledge score at Time 4 (M = 1.60, SD = 0.09) compared with Time 2 (M = 1.56, SD = .07); t (35) = 2.436, p = 0.02; effect size [d] = 0.4.

7.3.10 Comparison Between School Nurses' Asthma Knowledge Scores at Time 3 and Time 4

Although the mean asthma knowledge score at Time 3 (M = 1.62, SD = 0.07) was slightly higher than that at Time 4 (M = 1.60, SD = 0.09), the t-test showed no significant difference between school nurses' asthma knowledge scores at Time 3 and Time 4: t (35) = 1.47, p = .151; effect size[d] = 0.24.

Table 7.13 summarizes the comparisons of asthma knowledge scores between time points.

Table 7.13. Comparison of Asthma Knowledge Scores Across Time Points

Comparison	Time Points	*Mean (*SD*)	*P*-Value	*t*-test
1	Time 1 Time 2	0.07 (0.19)	.04**	2.12
2	Time 1 Time 3	0.14 (0.15)	0.00**	5.37
3	Time 1 Time 4	0.12 (0.17)	.00**	4.37
4	Time 2 Time 3	0.06 (0.11)	.00**	4.24

*Mean difference, **Significant

7.3.11 Correlation Between Participants' Demographics and Asthma Knowledge Level

There was a non-significant correlation between participants' age, level of education, years of nursing experience and years of school nursing experience and their asthma knowledge score (Table 7.14).

Table 7.14. Correlation Between Demographics and Asthma Knowledge Score at Times 1, 2, 3, and 4

Asthma Knowledge Level	Age		Level of Education		Years of Nursing Experience		Years of School Nursing Experience	
	Corr. Coeff.*	Sig.	Corr. Coeff.	Sig.	Corr. Coeff.	Sig.	Corr. Coeff.	Sig.
Time 1	.109	.526	.242	.1156	.221	.196	-.166	.334
Time 2	.056	.746	.007	.970	.057	.742	-.049	.776
Time 3	.084	.625	-.269	.113	.233	.171	-.098	.569
Time 4	-.036	.837	.131	.448	.113	.511	-.216	.206

* Spearman Correlation Coefficient

7.4 Asthma Self-Efficacy Questionnaire

The results of the 19-item Asthma Self-Efficacy Questionnaire are presented by discussing the overall self-efficacy scores followed by a comparison of the results across the four data collection time points.

7.4.1 Overall Self-Efficacy Scores

The overall mean self-efficacy score was 62.46 (SD = 6.98). The score ranged from a minimum of 41 to a maximum of 76. The mean scores for all self-efficacy statements were higher postintervention than preintervention. The mean, minimum and maximum self-efficacy scores for Time 1, Time 2, Time 3 and Time 4 were calculated (Table 7.15).

Table 7.15. School Nurses' Asthma Self-Efficacy Mean Scores and Standard Deviation (SD)

	Time 1 (N = 36)	Time 2 (N = 36)	Time 3 (N = 36)	Time 4 (N = 36)	Overall
Minimum Score	41	57	55	54	41
Maximum Score	64	76	73	69	76
Mean Score	54.78	67.19	64.64	63.22	62.46
SD	5.698	5.874	5.145	4.072	6.983

7.4.2 Asthma Self-Efficacy Scores of School Nurses at Time 1 before SNAEP

School nurses' self-efficacy mean score at Time 1 was 54.78 (±5.698) with a minimum score of 41 and a maximum score of 64. The items associated with the highest mean self-efficacy score were related to communication between school nurses and healthcare providers (3.80 ± 0.40) and communication with parents (3.53 ± 0.50). These items were "*When I have concerns or questions about a child's asthma management, I feel comfortable contacting the primary health care provider and discussing my concerns*" and "*When I have concerns or questions about a child's asthma management, I feel comfortable contacting the child's parents and discussing my*

concerns", respectively. These two items were followed by the item related to determining when to send students with asthma to the emergency room (*M* = 3.33, *SD* = .624).

The questionnaire items with the lowest self-efficacy scores were related to medication use and the use of a PFM. Twenty-seven (75%) nurses responded with either false or mostly false in rating their ability to choose the correct asthma medication on the basis of asthma symptoms (*M* =1.78, *SD* = 0.83). Half of school nurses (50%, *n* = 18) responded with false and mostly false to their self-efficacy regarding dry powder inhaler (M = 1.78, SD = 0.832) and PFM use (*M* = 2.28, *SD* = 1.00). Table 7.16 presents school nurses' responses to the asthma self-efficacy questionnaire at Time 1 starting from items with the highest self-efficacy score to items with the lowest self-efficacy score.

Table 7.16. School Nurses' Responses to the Asthma Self-efficacy Questionnaire at Time 1 (Before SNAEP)

	Asthma Self-Efficacy items	N*True (%)	N*Mostly True (%)	N*Mostly False (%)	N*False (%)	Mean	SD
1	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the primary health care provider and discussing my concerns.	29 (80.6)	7 (19.4)	0 (0.0)	0 (0.0)	3.81	0.401
2	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the child's parents and discussing my concerns.	19 (52.8)	17(47.2)	0 (0.0)	0 (0.0)	3.53	0.506
3	I can determine when to send the student with asthma to the emergency room.	13 (36.1)	22 (61.1)	0 (0.0)	2.8%	3.31	0.624
4	I can determine when to send the student with asthma back to the classroom.	12 (33.3)	20 (55.6)	2 (5.6)	2 (5.6)	3.17	0.775
5	I can help the student with asthma avoid asthma symptoms.	12 (33.3)	20 (55.6)	2 (5.6)	2 (5.6)	3.17	0.775
6	I have the ability to evaluate the effectiveness of the self-management efforts of the student with asthma.	14 (38.9)	16 (44.4)	3 (8.3)	3 (8.3)	3.14	0.899
7	I can influence students with asthma and their parents to reduce asthma triggers at home by teaching asthma environmental control.	8 (22.2)	22 (61.1)	4 (11.1)	2 (5.6)	3.00	0.756
8	I can provide asthma instruction in a clear manner that the students can understand.	7 (19.4)	24 (66.7)	3 (8.3)	2 (5.6)	3.00	0.717
9	l can determine the severity of an asthma attack based on the symptoms.	4 (11.1)	28 (77.8)	2 (5.6)	2 (5.6)	2.94	0.630
10	I can correctly demonstrate how to use a peak flow meter.	7 (19.4)	19 (52.8)	7 (19.4)	3 (8.3)	2.83	0.845
11	I can take the necessary steps to avoid or to manage an asthma attack effectively.	3 (8.3)	24 (66.7)	9 (25.0)	0 (0.0)	2.83	0.561
12	I can correctly assess the needs of students with asthma.	4 (11.1)	25 (69.4)	3 (8.3)	4 (11.1)	2.81	0.786
13	I can determine when to administer asthma medication when the student with asthma is having symptoms.	2 (5.6)	27 (75.0)	5 (13.9)	2 (5.6)	2.81	0.624

14	I have a lot of confidence in my ability to detect the early warning signs of asthma.	2 (5.6)	27 (75.0)	5 (13.9)	2 (5.6)	2.81	0.624
15	I can determine whether the asthma medication is working for a student having an asthma exacerbation.	3 (8.3)	24 (66.7)	5 (13.9)	4 (11.1)	2.72	0.779
16	I can manage an asthma attack in school without needing to send the child home or to the emergency room.	1 (2.8)	21 (58.3)	8 (22.2)	6 (16.7)	2.47	0.810
17	I can teach students with asthma to choose the correct self-management response based on the red, yellow and green light system.	4 (11.1)	16 (44.4)	6 (16.7)	10(27.8)	2.39	1.022
18	I can correctly demonstrate how to use a dry powder inhaler.	3 (8.3)	15 (41.7)	7 (19.4)	11(30.6)	2.28	1.003
19	I can correctly choose which asthma medication to give depending upon which asthma symptoms the student is experiencing.	0 (0.0)	9 (25.0)	10 (27.8)	17(47.2)	1.78	0.832
	overall	21.5%	56.0%	11.8%	10.7%	2.88	0.735

7.4.3 Asthma Self-Efficacy Scores of School Nurses at Time 2 (Immediately After SNAEP)

School nurses' self-efficacy mean score at Time 2 was 67.19 (*SD* = 5.874), with a minimum score of 57 and a maximum score of 76. All item mean scores were higher than the respective baseline mean scores. School nurses exhibited the highest self-efficacy score in contacting health care providers about a child's asthma (*M* = 3.91, *SD* = 0.28; *p* = .044). The second item with a high mean self-efficacy level (*M* = 3.69, *SD* = 0.47; *p* = .000) was related to helping students with asthma avoid asthma symptoms and managing exacerbation effectively. All 36 school nurses had higher self-efficacy in teaching students and their caregivers about asthma environmental control at Time 2 compared with Time 1 (M = 3.67, SD = 0.48; *p* = .000). Furthermore, there was a significant difference in the mean self-efficacy level in terms of providing asthma instructions to students between Time 2 and Time 1 (*M* = 3.58, *SD* = 0.50; *p* = .000).

Items with the lowest yet significantly different mean scores were "*I can correctly demonstrate how to use a dry powder inhaler*" (*M* = 3.03, *SD* = 1.03; *p* = .000) and "*I can correctly choose*

which asthma medication to give depending upon which asthma symptoms the student is experiencing" (*M* = 3.39, *SD* = 0.49; *p* = .001). These were the same items with the lowest self-efficacy score as Time 1. Table 7.17 presents school nurses' responses to the asthma self-efficacy questionnaire at Time 2 starting from items with the highest self-efficacy score to items with the lowest self-efficacy score.

Table 7.17. Asthma Self-efficacy Responses for School Nurses at Time 2 (Immediately After SNAEP)

	Asthma Self-Efficacy items	N*True (%)	N*Mostly True (%)	N*Mostly False (%)	N*False (%)	Mean	SD
1	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the primary health care provider and discussing my concerns.	33 (91.7)	3 (8.3)	0 (0.0)	0 (0.0)	3.92	.280
2	I can help the student with asthma avoid asthma symptoms.	25 (69.4)	11 (30.6)	0 (0.0)	0 (0.0)	3.69	.467
3	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the child's parents and discussing my concerns.	24 (66.7)	12 (33.3)	0 (0.0)	0 (0.0)	3.67	.478
4	I can influence students with asthma and their parents to reduce asthma triggers at home by teaching asthma environmental control.	24 (66.7)	12 (33.3)	0 (0.0)	0 (0.0)	3.67	.478
5	I can determine when to send the student with asthma to the emergency room.	22 (61.1)	14 (38.9)	0 (0.0)	0 (0.0)	3.61	.494
6	I can take the necessary steps to avoid or to manage an asthma attack effectively.	22 (61.1)	14 (38.9)	0 (0.0)	0 (0.0)	3.61	.494
7	I can determine when to send the student with asthma back to the classroom.	21 (58.3)	15 (41.7)	0 (0.0)	0 (0.0)	3.58	.500
8	I can provide asthma instruction in a clear manner that the students can understand.	21 (58.3)	15 (41.7)	0 (0.0)	0 (0.0)	3.58	.500
9	I can teach students with asthma to choose the correct self-management response based on the red, yellow and green light system.	20 (55.6)	16 (44.4)	0 (0.0)	0 (0.0)	3.56	.504

	Asthma Self-Efficacy items	N*True (%)	N*Mostly True (%)	N*Mostly False (%)	N*False (%)	Mean	SD
10	l can determine the severity of an asthma attack based on the symptoms.	20 (55.6)	16 (44.4)	0 (0.0)	0 (0.0)	3.56	.504
11	I have a lot of confidence in my ability to detect the early warning signs of asthma.	20 (55.6)	16 (44.4)	0 (0.0)	0 (0.0)	3.56	.504
12	I have the ability to evaluate the effectiveness of the self-management efforts of the student with asthma.	19 (52.8)	17 (47.2)	0 (0.0)	0 (0.0)	3.53	.506
13	I can determine whether the asthma medication is working for a student having an asthma exacerbation.	19 (52.8)	17 (47.2)	0 (0.0)	0 (0.0)	3.53	.506
14	I can correctly assess the needs of students with asthma.	17 (47.2)	18 (50.0)	1 (2.8)	0 (0.0)	3.44	.558
15	I can correctly demonstrate how to use a peak flow meter.	16 (44.4)	20 (55.6)	0 (0.0)	0 (0.0)	3.44	.504
16	I can determine when to administer asthma medication when the student with asthma is having symptoms.	15 (41.7)	21 (58.3)	0 (0.0)	0 (0.0)	3.42	.500
17	I can manage an asthma attack in school without needing to send the child home or to the emergency room.	16 (44.4)	19 (52.8)	1 (2.8)	0 (0.0)	3.42	.554
18	I can correctly choose which asthma medication to give depending upon which asthma symptoms the student is experiencing.	14 (38.9)	22 (61.1)	0 (0.0)	0 (0.0)	3.39	.494
19	I can correctly demonstrate how to use a dry powder inhaler.	15 (41.7)	11 (30.6)	6 (16.7)	4(11.1)	3.03	1.028
	overall	56%	42.3%	1.2%	0.6%	3.45	5.19

7.4.4 Asthma Self-Efficacy Scores of Schools Nurses at Time 3

School nurses' self-efficacy mean score at Time 3 was 64.64 (*SD* = 5.145), with a minimum score of 55 and a maximum score of 73. There was a reduction in scores for 15 asthma self-efficacy items compared to Time 2; however, the self-efficacy score for these items was still higher than at Time 1. Items with the highest self-efficacy score in Time 3 were the same as in Time 2 for the following items: "*When I have concerns or questions about a child's asthma management, I feel comfortable contacting the primary health care provider and discussing my concerns" (M* = 3.83, *SD* = .377*)*, and "*I can help the student with asthma avoid asthma*

symptoms" (*M* =3.72 , *SD* = .454). The mean scores for two items remained the same as those at Time 2: "*I can determine when to send a student to the ER*" (*M* = 3.61, *SD*= 0.494) and "*I have the ability to evaluate the effectiveness of the self-management efforts of the student with asthma*" (*M* = 3.53, *SD* = 0.560).

As in Time 2, the item concerning using a dry powder inhaler had the lowest mean self-efficacy score (*M* = 2.80, *SD* = 0.855). The second item with the least asthma self-efficacy score was school nurses' ability to choose asthma medication on the basis of asthma symptoms—seven nurses (19.44%) chose the response "false" or "mostly false" (*M* = 2.88, *SD* = 0.784). Table 6.18 presents school nurses' responses to the asthma self-efficacy questionnaire at Time 3 starting from items with the highest self-efficacy score to items with the lowest self-efficacy score.

Table 6.18. School Nurses' Responses to the Asthma Self-efficacy Questionnaire at Time 3 (Three3 Months Post SNAEP)

	Asthma Self-Efficacy items	N*True (%)	N*Mostly True (%)	N*Mostly False (%)	N*False (%)	Mean	SD
1	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the primary health care provider and discussing my concerns.	30 (83.3)	6 (16.7)	0 (0.0)	0 (0.0)	3.83	.377
2	I can help the student with asthma avoid asthma symptoms.	26 (72.2)	10 (27.8)	0 (0.0)	0 (0.0)	3.72	.454
3	I can determine when to send the student with asthma back to the classroom.	24 (66.7)	12 (33.3)	0 (0.0)	0 (0.0)	3.66	.478
4	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the child's parents and discussing my concerns.	22 (61.1)	14 (38.9)	0 (0.0)	0 (0.0)	3.61	.494
5	I can determine when to send the student with asthma to the emergency room.	22 (61.1)	14 (38.9)	0 (0.0)	0 (0.0)	3.61	.494
6	I have a lot of confidence in my ability to detect the early warning signs of asthma.	21 (58.3)	15 (41.7)	0 (0.0)	0 (0.0)	3.58	.500
7	I can influence students with asthma and their parents to reduce asthma	20 (55.6)	16 (44.4)	0 (0.0)	0 (0.0)	3.55	.503

	triggers at home by teaching asthma environmental control.						
8	I can provide asthma instruction in a clear manner that the students can understand.	20 (55.6)	16 (44.4)	0 (0.0)	0 (0.0)	3.55	.503
9	I have the ability to evaluate the effectiveness of the self-management efforts of the student with asthma.	20 (55.6)	15 (41.7)	1 (2.8)	0 (0.0)	3.53	.559
10	l can determine the severity of an asthma attack based on the symptoms.	18 (50.0)	18 (50.0)	0 (0.0)	0 (0.0)	3.50	.507
11	I can take the necessary steps to avoid or to manage an asthma attack effectively.	18 (50.0)	17 (47.2)	1 (2.8)	0 (0.0)	3.47	.559
12	I can correctly assess the needs of students with asthma.	17 (47.2)	17 (47.2)2	2 (5.6)	0 (0.0)	3.41	.603
13	I can determine whether the asthma medication is working for a student having an asthma exacerbation.	14 (38.9)	19 (52.8)	3 (8.3)	0 (0.0)	3.30	.624
14	I can correctly demonstrate how to use a peak flow meter.	12 (33.3)	21 (58.3)	3 (8.3)	0 (0.0)	3.25	.603
15	I can determine when to administer asthma medication when the student with asthma is having symptoms.	11 (30.6)	22 (61.1)	3 (8.3)	0 (0.0)	3.22	.590
16	I can teach students with asthma to choose the correct self-management response based on the red, yellow and green light system.	8 (22.2)	23 (63.9)	4 (11.1)	1 (2.8)	3.05	.673
17	I can manage an asthma attack in school without needing to send the child home or to the emergency room.	8 (22.2)	22 (61.1)	6 (16.7)	0 (0.0)	3.05	.629
18	I can correctly choose which asthma medication to give depending upon which asthma symptoms the student is experiencing.	6 (16.7)	23 (63.9)	4 (11.1)	3 (8.3)	2.88	.784
19	I can correctly demonstrate how to use a dry powder inhaler.	6 (16.7)	21 (58.3)	5 (13.9)	4 (11.1)	2.80	.855
	overall	47.2%	46.9%	4.7%	1.2%	3.40	5.68

7.4.5 Asthma Self-Efficacy Scores of School Nurses at Time 4

School nurses' self-efficacy mean score at Time 4 was 63.22 (SD = 4.072), with a minimum score of 54 and a maximum score of 69. The mean scores for 13 items showed significant improvement from the baseline, and the mean scores for 14 items were lower than those at Time 3. Communication with health care providers remained the item with the highest self-efficacy

score (M = 3.86, SD = 0.351), although the mean score did not significantly differ between time points (p = .535). The second item with the highest self-efficacy score was the same item in Time 4 as in Time 2 and Time 3: "*I can help the student with asthma avoid asthma symptoms"* (M = 3.83, SD = .377). School nurses sustained their self-efficacy scores in detecting early warning signs of asthma (M = 3.66, SD = 0.565; p = .000).

School nurses also showed a lower mean self-efficacy score at Time 4 than that at Time 2 and Time 3 but higher than at Time 1 in teaching students with asthma to choose self-management responses on the basis of green, yellow and red zones (M = 2.77, SD = 0.721; p = .051); however, this difference was statistically non-significant. Compared to the 16 school nurses (44.44%) who responded with false or mostly false to this item at Time 1, 5 (13.88%) and 10 (27.77%) nurses reported the same response of false and mostly false at Time 3 and Time 4.

The items with the lowest mean scores were items concerning the use of dry powder inhaler (M = 2.56, SD = 0.735, p = .134) and choosing asthma medication on the basis of the student's symptoms (M = 2.56, SD = 0.809, p = 0.001). In response to the later statement "*I can correctly choose which asthma medication to give depending upon which asthma symptoms the student is experiencing*", 15 (41.66%) nurses responded with either "false" or "mostly false" at Time 4, compared to seven nurses (19.44%) at Time 3. Table 7.19 presents school nurses' responses to the asthma self-efficacy questionnaire at Time 4 starting from items with the highest self-efficacy score to items with the lowest self-efficacy score.

Table 7.19. School Nurses' Responses to the Asthma Self-efficacy Questionnaire at Time 4 (6 Six Months Post SNAEP)

	Asthma Self-Efficacy items	**N*True (%)**	**N*Mostly True (%)**	**N*Mostly False (%)**	**N*False (%)**	**Mean**	**SD**
1	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the primary health care provider and discussing my concerns.	31 (86.1)	5 (13.9)	0 (0.0)	0 (0.0)	3.86	.351
2	I can help the student with asthma avoid asthma symptoms.	30 (83.3)	6 (16.7)	0 (0.0)	0 (0.0)	3.83	.377
3	I can determine when to send the student with asthma back to the classroom.	24 (66.7)	12 (33.3)	0 (0.0)	0 (0.0)	3.67	.478

	Asthma Self-Efficacy items	N*True (%)	N*Mostly True (%)	N*Mostly False (%)	N*False (%)	Mean	SD
4	I have a lot of confidence in my ability to detect the early warning signs of asthma.	24 (66.7)	12 (33.3)	0 (0.0)	0 (0.0)	3.67	.478
5	I can influence students with asthma and their parents to reduce asthma triggers at home by teaching asthma environmental control.	23 (63.9)	13 (36.1)	0 (0.0)	0 (0.0)	3.64	.487
6	I can determine when to send the student with asthma to the emergency room.	23 (63.9)	13 (36.1)	0 (0.0)	0 (0.0)	3.64	.487
7	l can determine the severity of an asthma attack based on the symptoms.	23 (63.9)	13 (36.1)	0 (0.0)	0 (0.0)	3.64	.487
8	I can provide asthma instruction in a clear manner that the students can understand.	22 (61.1)	14 (38.9)	0 (0.0)	0 (0.0)	3.61	.494
9	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the child's parents and discussing my concerns.	16 (44.4)	20 (55.6)	0 (0.0)	0 (0.0)	3.44	.504
10	I can take the necessary steps to avoid or to manage an asthma attack effectively.	14 (38.9)	21 (58.3)	1 (2.8)	0 (0.0)	3.36	.543
11	I can correctly assess the needs of students with asthma.	14 (38.9)	19 (52.8)	3 (8.3)	0 (0.0)	3.31	.624
12	I have the ability to evaluate the effectiveness of the self-management efforts of the student with asthma.	13 (36.1)	20 (55.6)	3 (8.3)	0 (0.0)	3.28	.615
13	I can correctly demonstrate how to use a peak flow meter.	11 (30.6)	21 (58.3)	4 (11.1)	0 (0.0)	3.19	.624
14	I can determine whether the asthma medication is working for a student having an asthma exacerbation.	11 (30.6)	21 (58.3)	4 (11.1)	0 (0.0)	3.19	.624
15	I can determine when to administer asthma medication when the student with asthma is having symptoms.	9 (25.0)	22 (61.1)	5 (13.9)	0 (0.0)	3.11	.622
16	I can manage an asthma attack in school without needing to send the child home or to the emergency room.	6 (16.7)	20 (55.6)	10 (27.8)	0 (0.0)	2.89	.667
17	I can teach students with asthma to choose the correct self-management response based on the red, yellow and green light system.	4 (11.1)	22 (61.1)	8 (22.2)	2 (5.6)	2.78	.722
18	I can correctly demonstrate how to use a dry powder inhaler.	2 (5.6)	19 (52.8)	12 (33.3)	3 (8.3)	2.56	.735
19	I can correctly choose which asthma medication to give depending upon which asthma symptoms the student is experiencing.	3 (8.3)	18 (50.0)	11 (30.6)	4 (11.1)	2.56	.809
	overall	44.3%	45.5%	8.9%	1.3%	3.30	5.65

Table 7.20 shows the number and percentage of school nurses' responses to the 19-item asthma self-efficacy questionnaire in the four data collection time point

Table 7.20. School Nurses' Asthma Self-Efficacy Responses at Time1, Time 2, Time 3, and Time 4

	Time 1				**Time 2**				**Time 3**				**Time 4**			
Asthma Self-Efficacy items	N*(%) True	N* (%) Mostly true	N*(%) Mostly false	N*(%) False	N*(%) True	N* (%) Mostly true	N*(%) Mostly false	N*(%) False	N*(%) True	N* (%) Mostly true	N*(%) Mostly false	N*(%) False	N*(%) True	N* (%) Mostly true	N*(%) Mostly false	N*(%) False
When I have concerns, I feel comfortable contacting the primary health care provider	80.6%	19.4%	0.0%	0.0%	91.7%	8.3%	0.0%	0.0%	83.3%	16.7%	0.0%	0.0%	86.1%	13.9%	0.0%	0.0%
When I have concerns, I feel comfortable contacting the child's parents	52.8%	47.2%	0.0%	0.0%	66.7%	33.3%	0.0%	0.0%	61.1%	38.9%	0.0%	0.0%	44.4%	55.6%	0.0%	0.0%
I can correctly assess the needs of students with asthma.	11.1%	69.4%	8.3%	11.1%	47.2%	50.0%	2.8%	0.0%	47.2%	47.2%	5.6%	0.0%	38.9%	52.8%	8.3%	0.0%
I can correctly demonstrate how to use a dry powder inhaler.	8.3%	41.7%	19.4%	30.6%	41.7%	30.6%	16.7%	11.1%	16.7%	58.3%	13.9%	11.1%	5.6%	52.8%	33.3%	8.3%
I can correctly demonstrate how to use a peak flow meter.	19.4%	52.8%	19.4%	8.3%	44.4%	55.6%	0.0%	0.0%	33.3%	58.3%	8.3%	0.0%	30.6%	58.3%	11.1%	0.0%
I have the ability to evaluate the effectiveness of the self-management efforts of the student with asthma.	38.9%	44.4%	8.3%	8.3%	52.8%	47.2%	0.0%	0.0%	55.6%	41.7%	2.8%	0.0%	36.1%	55.6%	8.3%	0.0%
I can correctly choose which asthma medication	0.0%	25.0%	27.8%	47.2%	38.9%	61.1%	0.0%	0.0%	16.7%	63.9%	11.1%	8.3%	8.3%	50.0%	30.6%	11.1%

	Time 1				Time 2				Time 3				Time 4			
to give depending upon which asthma symptoms the student is experiencing.																
I can influence students with asthma and their parents to reduce asthma triggers at home by teaching asthma environmental control.	22.2%	61.1%	11.1%	5.6%	66.7%	33.3%	0.0%	0.0%	55.6%	44.4%	0.0%	0.0%	63.9%	36.1%	0.0%	0.0%
I can teach students with asthma to choose the correct self-management response based on the red, yellow and green light system.	11.1%	44.4%	16.7%	27.8%	55.6%	44.4%	0.0%	0.0%	22.2%	63.9%	11.1%	2.8%	11.1%	61.1%	22.2%	5.6%
I can determine when to administer asthma medication when the student with asthma is having symptoms.	5.6%	75.0%	13.9%	5.6%	41.7%	58.3%	0.0%	0.0%	30.6%	61.1%	8.3%	0.0%	25.0%	61.1%	13.9%	0.0%
I can determine when to send the student with asthma to the emergency room.	36.1%	61.1%	0.0%	2.8%	61.1%	38.9%	0.0%	0.0%	61.1%	38.9%	0.0%	0.0%	63.9%	36.1%	0.0%	0.0%
I can determine when to send the student with asthma back to the classroom.	33.3%	55.6%	5.6%	5.6%	58.3%	41.7%	0.0%	0.0%	66.7%	33.3%	0.0%	0.0%	66.7%	33.3%	0.0%	0.0%
I can manage an asthma attack in	2.8%	58.3%	22.2%	16.7%	44.4%	52.8%	2.8%	0.0%	22.2%	61.1%	16.7%	0.0%	16.7%	55.6%	27.8%	0.0%

	Time 1				Time 2				Time 3				Time 4			
school without needing to send the child home or to the emergency room.																
I can provide asthma instruction in a clear manner that the students can understand.	19.4%	66.7%	8.3%	5.6%	58.3%	41.7%	0.0%	0.0%	55.6%	44.4%	0.0%	0.0%	61.1%	38.9%	0.0%	0.0%
I can determine whether the asthma medication is working for a student having an asthma exacerbation.	8.3%	66.7%	13.9%	11.1%	52.8%	47.2%	0.0%	0.0%	38.9%	52.8%	8.3%	0.0%	30.6%	58.3%	11.1%	0.0%
l can determine the severity of an asthma attack based on the symptoms.	11.1%	77.8%	5.6%	5.6%	55.6%	44.4%	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	63.9%	36.1%	0.0%	0.0%
I can help the student with asthma avoid asthma symptoms	33.3%	55.6%	5.6%	5.6%	69.4%	30.6%	0.0%	0.0%	72.2%	27.8%	0.0%	0.0%	83.3%	16.7%	0.0%	0.0%
I can take the necessary steps to avoid or to manage an asthma attack effectively.	8.3%	66.7%	25.0%	0.0%	61.1%	38.9%	0.0%	0.0%	50.0%	47.2%	2.8%	0.0%	38.9%	58.3%	2.8%	0.0%
I have a lot of confidence in my ability to detect the early warning signs of asthma.	5.6%	75.0%	13.9%	5.6%	55.6%	44.4%	0.0%	0.0%	58.3%	41.7%	0.0%	0.0%	66.7%	33.3%	0.0%	0.0%
overall	21.5%	56.0%	11.8%	10.7%	56.0%	42.3%	1.2%	0.6%	47.2%	46.9%	4.7%	1.2%	44.3%	45.5%	8.9%	1.3%

7.4.6 Differences in Asthma Self-Efficacy Scores Between Time 1 and Time 2

Overall, there was statistically significant improvement in all items at Time 2 when compared to Time 1. A paired *t*-test showed that the school nurses exhibited a significantly higher mean self-efficacy score at Time 2 (3.54 ± 0.31) compared with Time 1: (2.88 ± 0.299), *t (35)* = 10.687, *p* = .000; effect size [*d*] = 1.78.

7.4.7 Differences in Asthma Self-Efficacy Scores Between Time 1 and Time 3

A paired *t*-test showed that school nurses exhibited a significantly higher mean asthma self-efficacy score at Time 3 (3.40 ± 0.27) than at Time 1: (2.88 ± 0.29), *t (35)* = 8.884, *p* = .000; effect size [*d*] = 1.48.

7.4.8 Differences in Asthma Self-Efficacy Scores Between Time 1 and Time 4

The mean asthma self-efficacy score at Time 4 (3.32 ± 0.21) was significantly higher than that at Time 1 (2.88 ± 0.29). School nurses showed a significantly higher self-efficacy score at Time 4 compared with Time 1, *t* (35) = 7.696, *mk*

7.4.9 Differences in Asthma Self-Efficacy Scores Between Time 2 and Time 3

The mean asthma self-efficacy score at Time 2 (3.54 ± 0.31) was significantly higher than that at Time 3 (3.40 ± 0.27). School nurses exhibited higher self-efficacy scores at Time 2 compared to Time 3, as shown by a paired *t*-test, *t* (35) = 4.565, *p* = .000; effect size [*d*] = 0.76.

7.4.10 Differences in Asthma Self-Efficacy Scores Between Time 2 and Time 4

The mean asthma self-efficacy score at Time 2 (3.54 ± 0.31) was slightly and significantly higher than that at Time 4 (3.32 ± 0.21). According to a paired *t*-test, school nurses exhibited a higher self-efficacy score at Time 2 compared with Time 4: t (25) = 5.790, p = .000; effect size[*d*] = 0.97.

7.4.11 Differences in Self-Efficacy Scores Between Time 3 and Time 4

A paired *t*-test revealed that the mean asthma self-efficacy score at Time 3 (3.40 ± 0.27) was significantly higher than that at Time 4: (3.32 ± 0.21); *t (35)* = 3.804, p = .001, effect size[*d*] = .63.

Table 7.21 provides the mean, *SD* and *p*-value for the t-test for each statement. The statistical significance was defined as a *p*-value of <0.05. Comparisons were made on the effect of the intervention programme immediately post intervention (Time 2) and six months post intervention (Time 4).

Table 7.21. Mean, Standard Deviation (SD), and Effect of the Intervention Programme on Each Self-Efficacy Statement Immediately After (Time 1) and 6 Six Months Post intervention (Time 4)

Statement	**Time 1**	**Time 2**	**Time 3**	**Time 4**	**Effect**	
	Mean (SD)	Mean (*SD)*	Mean (*SD)*	Mean (*SD)*	**P*-value	***P*-Value
When I have concerns, I feel comfortable contacting the primary health care provider	3.81 (0.401)	3.92 (0.280)	3.83 (0.378)	3.86 (0.35)	.044	.535
When I have concerns, I feel comfortable contacting the child's parents	3.53 (0.51)	3.67 (0.48)	3.61 (0.49)	3.44 (0.50)	.023	.324
I can correctly assess the needs of students with asthma.	2.81 (0.79)	3.44 (0.56)	3.42 (0.60)	3.31 (0.62)	.000	.003
I can correctly demonstrate how to use a dry powder inhaler.	2.28 (1.00)	3.03 (1.03)	2.81 (0.85)	2.56 (0.74)	.000	.134
I can correctly demonstrate how to use a peak flow meter.	2.83 (0.85)	3.44 (0.50)	3.25 (0.60)	3.19 (0.624)	.000	.030
I have the ability to evaluate the effectiveness of the self-management efforts of the student with asthma.	3.14 (0.89)	3.53 (0.51)	3.53 (0.56)	3.28 (0.62)	.003	.304
I can correctly choose which asthma medication to give depending upon which asthma symptoms the student is experiencing.	1.78 (0.83)	3.39 (0.49)	2.89 (0.78)	2.56 (0.82)	.000	.001
I can influence students with asthma and their parents to reduce asthma triggers at home	3.00 (0.75)	3.67 (0.47)	3.56 (0.50)	3.64 (0.48)	.000	.000

Statement	Time 1	Time 2	Time 3	Time 4	Effect	
	Mean (SD)	Mean (*SD)*	Mean (*SD)*	Mean (*SD)*	**P*-value	***P*-Value
by teaching asthma environmental control.						
I can teach students with asthma to choose the correct self-management response based on the red, yellow, and green light system.	2.39 (1.02)	3.56 (0.50)	3.06 (0.67)	2.78 (0.72)	.000	.051
I can determine when to administer asthma medication when the student with asthma is having symptoms.	2.81 (0.62)	3.42 (0.50)	3.22 (0.59)	3.11 (0.62)	.000	.039
I can determine when to send the student with asthma to the emergency room.	3.31 (0.62)	3.61 (0.49)	3.61 (0.49)	3.64 (0.48)	.001	.003
I can determine when to send the student with asthma back to the classroom.	3.17 (0.78)	3.58 (0.50)	3.67 (0.48)	3.67 (0.48)	.000	.001
I can manage an asthma attack in school without needing to send the child home or to the emergency room.	2.47 (0.81)	3.42 (0.55)	3.06 (0.63)	2.89 (0.67)	.000	0.026
I can provide asthma instruction in a clear manner that the students can understand.	3.00 (0.72)	3.58 (0.50)	3.56 (0.50)	3.61 (0.494)	.000	.000
I can determine whether the asthma medication is working for a student having an asthma exacerbation.	2.72 (0.78)	3.53 (0.51)	3.31 (0.62)	3.19 (0.62)	.000	.008
I can determine the severity of an asthma attack based on the symptoms.	2.94 (0.63)	3.56 (0.50)	3.50 (0.51)	3.64 (0.49)	.000	.000
I can help the student with asthma avoid asthma symptoms.	3.17 (0.78)	3.69 (0.47)	3.72 (0.45)	3.83 (0.38)	.000	.000
I can take the necessary steps to avoid or to manage an asthma attack effectively.	2.83(0.561)	3.61 (0.494)	3.47 (0.56)	3.36 (0.54)	.000	.000
I have a lot of confidence in my ability to detect the early warning signs of asthma.	2.81(0.624)	3.56 (0.504)	3.58 (0.50)	3.67 (0.48)	.000	.000
Overall	2.88 (0.74)	3.54 (0.52)	3.40 (0.57)	3.33 (0.57)		

**The difference in self-efficacy scores between Time 1 (before the intervention) and Time 2 (immediately after the intervention)*

***The difference in self-efficacy scores between Time 1 (before the intervention) and Time 4 (six months after the intervention)*

Table 7.22 summarizes the comparisons of asthma self-efficacy scores between time points.

Table 7.22. Comparisons of Asthma Self-efficacy Scores

Groups	Mean Difference	*SD*	*df*	*t*-score	*P*-value
Time 1 & 2	.65351	.36689	35	-10.687	.000
Time 1 & 3	.51901	.35051	35	-8.884	.000
Time 1 & 4	.44444	.34649	35	-7.696	.000
Time 2 & 3	.13450	.17679	35	4.565	.000
Time 2 & 4	.20906	.21664	35	5.790	.000
Time 3 & 4	.7456	.11760	35	3.804	.001

7.5 Correlation Between Asthma Self-Efficacy and School Nurses' Demographics

There was no correlation between school nurses' demographic information and their self-efficacy scores. Table 7.23 presents the correlation coefficient results.

Table 7.23. Correlation between School Nurses' Asthma Self-Efficacy Scores and Their Demographics at Time 1, 2, 3, and 4

Asthma Knowledge Level	Age		Level of Education		Years of Nursing Experience		Years of School Nursing Experience	
	Corr. Coeff.*	Sig.	Corr. Coeff.	Sig.	Corr. Coeff.	Sig.	Corr. Coeff.	Sig.
Time 1	-.020	.909	.115	.504	-0.72	.678	.058	.736
Time 2	.191	.263	.057	.741	.189	.270	.061	.723
Time 3	.262	.123	-.024	.891	.291	.085	.014 .936	
Time 4	.128	.456	-.100	.563	.1226	.462	.107 .534	

* Spearman Correlation Coefficient

7.6 Correlation Between Asthma Knowledge and Asthma Self-Efficacy

There was a strong positive correlation between school nurses' asthma knowledge and self-efficacy levels at Time 1 (before the programme). This correlation was low immediately after SNAEP. However, no correlation was found between asthma knowledge and asthma self-

efficacy at Time 3 and Time 4. Table 16.23 presents the correlation between the two questionnaires.

Table 7.24. Correlation Between Asthma Knowledge and Asthma Self-Efficacy at the Four Data Collection Time Points

Time 1		**Asthma Knowledge**
Asthma Self-Efficacy	Pearson Correlation	**.908
	Sig. (2.tailed)	.000
Time 2		**Asthma Knowledge**
Asthma Self-Efficacy	Pearson Correlation	**.440
	Sig. (2.tailed)	.007
Time 3		**Asthma Knowledge**
Asthma Self-Efficacy	Pearson Correlation	.103
	Sig. (2.tailed)	.550
Time 4		**Asthma Knowledge**
Asthma Self-Efficacy	Pearson Correlation	.119
	Sig. (2.tailed)	.488

**. Correlation is significant at the 0.05 level (2-tailed)

7.7 Chapter Summary

It was evident that school nurses demonstrated improved knowledge and self-efficacy level after SNAEP, and this knowledge level was sustained at three and six months post intervention. The mean was higher at Time 2 and Time 3 because of the maximum score obtained by school nurses. The self-efficacy levels showed a tendency to decrease as time passed, with the highest self-efficacy measured at Time 2. The findings reported repeated significant change in specific knowledge and self-efficacy concepts like items related to medication administration and medication delivery devices. A strong positive correlation was found between school nurses' knowledge and self-efficacy levels before the intervention and a moderate positive correlation immediately after the programme. No correlation was found between school nurses' knowledge and self-efficacy scores and their demographic information. The next chapter presents a detailed discussion of the study findings in the context of the existing literature.

Chapter 8: Discussion of Findings and Recommendations

8.1 Introduction

This chapter presents a discussion of the findings with reference to relevant literature in the context of Oman. The structure of the chapter is guided by the aim and objectives of the study. This study has two phases. Phase 1 explored the roles of school nurses, their functions and their asthma educational needs. Phase 2 assessed the impact of School Nurse Asthma Education Programme (SNAEP) on school nurses' asthma knowledge and self-efficacy levels. The evidence obtained from this study is compared with what is already known from the literature.

8.2 The Profile of School Nurses in Oman

There is a general consensus that before conducting a training programme, it is essential to identify the training needs. A needs assessment assists with tailoring interventions. Since the main purpose of phase 1 of this study was to explore the role, functions and asthma educational needs of school nurses in Oman, a needs assessment survey was necessary in order to assess the identified gaps in the current practice and determine what should be incorporated in phase 2 of the programme.

To promote a professional profile of school nurses, there is a need to validate it empirically. The literature suggests a lack of public awareness of not only the role of school nurses, but also the existence of school nursing services. The lack of literature examining the role of school nurses in Oman influences the visibility of the school nursing field. With poor visibility and lack of a school nursing profile, an empirical clarification of the role of school nurses can assist with the establishment and promotion of the school nursing field. The school nursing profession plays an important role in Oman due to the sizable number of school-aged children. School aged children and youth aged 5–24 years old comprise 39% of the Omani population (BTI Transformation Index, 2022). The current disease burden in Oman shows epidemiological transition from acute infections to non-communicable diseases (Chapter 2, Section 2.6). Efforts within schools are emphasised as strategic investments to tackle non-communicable diseases. In line with the WHO Country Cooperation Strategy (CCS) for the WHO and Oman (2018-

2025), addressing the needs of children and adolescents through school health is useful not only for preparedness and response in emergencies, but in addressing priority health issues, including NCDs (*Country Cooperation Strategy for WHO and Oman 2021–2025*, 2021).

The results of this study indicate that first aid, immunisation administration, health education and medication administration were the most commonly identified functions of school nurses. These functions also match the roles of school nurses as reported by Lineberry and Ickes (2015). The purpose of this systematic review (33 studies) was to examine the literature on the role and impact of school nurses in American elementary schools. The authors aimed to identify the ways in which nurses contribute to the health and wellbeing of students, as well as the challenges and limitations of their role.They reported that the role of school nurses can be categorised into four main areas: 1) health promotion and disease prevention, 2) management of acute issues like injuries, 3) management of chronic conditions and 4) psychological support (Lineberry & Ickes, 2015). In a qualitative study by Lineberry *et al*. (2018) school nurses describe their role as a multitude of duties, including the management of acute injuries and chronic conditions, medication administration, health promotion and prevention activities for both staff and students, coordination of care and resources and provision of emotional support (Lineberry et al., 2018). These studies concur with findings from a 24-year-old study by Calabrese et al. (1999) concerning the top nursing activities performed by school nurses. The implication of having the same results as those from 24 years ago concerning the role of performing first aid tasks is that this remains a critical role for school nurses in promoting the health and safety of students. Despite changes in the healthcare system and advancements in technology, the need for immediate first aid attention for acute illnesses and injuries among students persists. This finding suggests that first aid remains a key area of focus for school nursing practice and highlights the ongoing need for school nurses to be skilled in emergency care, triage and the administration of basic first aid. Additionally, this finding may suggest that other aspects of the school nursing role, such as providing health education, conducting health screenings and managing chronic health conditions, may have remained consistent over the past two decades. Overall, the finding that first aid remains a key task for school nurses highlights the ongoing need for school nursing services in promoting student health and wellbeing.

Perceptions of the role of school nurses by others may influence school nurses' own perceptions of their role, thereby potentially affecting their actions (Temel et al., 2017). Previous literature has also evaluated superintendents' and school nurses' perceptions of the role of school nurses in the US (Holt et al., 2003; Green & Reffel, 2009). Researchers found that administering first aid, performing screenings, managing immunisations and maintaining records were the top perceived functions of school nurses. In some studies that investigated the perceptions of primary school parents toward school nursing roles, the majority of the parents believed that first aid and emergency care were the most important roles for which the school nurse was primarily responsible (Read et al., 2009). Providing first aid and emergency care was also the most important school nursing role identified by school teachers (Mahat, 2022). Overwhelmingly, school nurses are seen as people that deliver first aid in schools, although their role is, in reality, much broader. As the main role that school nurses assume, first aid encompasses providing care for any type of medical emergency occurring at school. Asthma exacerbation is one such medical emergency that school nurses are expected to handle and respond to. Exacerbation can occur at any time due to potential exposure to triggers that vary from child to child. Every child with asthma has specific triggers and should receive education about them (Elliott et al., 2017). An important finding in this study is that school nurses recognise themselves as the main person managing asthma-related emergencies. More importantly, similar to the US data that indicated that over 3.2 million children had at least one documented asthma attack in 2016 (Butler et al., 2020), this current study found that asthma exacerbation is encountered by school nurses on a weekly base. Regarding the question on the documentation of asthma exacerbation, the majority of participants reported student health records as the place for documentation, yet the study found inconsistencies in the documentation of information by school nurses, reflecting an inconsistency in practice. The fact that school nurses are the only health care professional available at schools, where children spend most of their time, suggests the necessity of preparing school nurses to act in medical emergencies. Owing to their age, schoolchildren cannot be expected to independently self-manage asthma exacerbations. Therefore, the ability of school nurses to respond and treat these exacerbations is critical. Thus, more education might be needed for school nurses regarding how to manage an exacerbation. This would involve the demonstration that nurses can correctly identify asthma exacerbation signs and respond with the correct use of an inhaler. Interestingly, this study

indicated that the vast majority of school nurses did not use a PFM to monitor asthma, including nurses who encountered asthma exacerbation on a daily basis. PFM use is essential to assess worsening asthma and whether the medication is working or not (Chapter 2, Section 2.3.3.1). One possible explanation for this lack of PFM use by school nurses might be a lack of knowledge regarding its use. Quaranta and Spencer (2016) examined the barriers that school nurses face in managing asthma among school-aged children. The study was conducted using a qualitative research design and employed focus group interviews with school nurses in the US. The study reported a significant correlation between obtaining PFM measurements and the lack of knowledgeable school nurses. GINA guidelines have clearly stated that schoolchildren with asthma need to receive education on the proper use of PFM (Global Initiative for Asthma, 2022). Without a peak flow assessment prior to physical activity, school nurses have no perception of whether a student may be vulnerable to an asthma exacerbation or not. Studies highlighted the importance of using a PFM as a monitoring tool to prevent exacerbation among school-aged children with asthma (Saglani et al., 2019). A 12-month RCT investigated the effect of peak flow monitoring on the quality of life (QOL) of children with asthma. The treatment group that received peak flow monitoring training, while the control group received only asthma education. In phase one, both groups received baseline asthma education. In phase two, the treatment group received peak flow monitoring training, while the control group received additional asthma education. The study included 136 children with asthma aged 6 to 12 years old and their caregivers. Authors found that the treatment group had fewer asthma exacerbations compared to the control group. Children who received peak flow monitoring training had significant improvements in their asthma QOL compared to the control group. The study highlights the importance of asthma monitoring in schools using PFM (Burkhart et al., 2012).

The results of this study also indicate that, as a form of health promotion and disease prevention, immunisation administration is the second-most reported function of school nurses. The reason for this is that school nurses in Oman are responsible for immunisation administration for all students, unlike school nurses in Scotland, where they progressively delegated immunisation of all school children to a specialised team in an effort to standardise the role of school nurses (Wason et al., 2018). In the US, school nurses are expected to enhance vaccine uptake by reminding students, families and staff of immunisation schedules and to update immunisation

records (Holmes, Sheetz, et al., 2016). Previous literature suggests that immunisation administration in school settings promotes adherence among school students (Paul & Fabio, 2014; Perman et al., 2017) and emphasises the leadership role of school nurses in coordinating and administering immunisation (Lineberry et al., 2018).

The current study indicates the existence of uncertainty regarding medication administration policy, with more than 30% of school nurses unsure of whether one existed and 50% reporting that students are not permitted to self-administer oral asthma medication. It is worth mentioning that the vast majority of school nurses in this study (83.7 %, n = 41) indicated that they supervise students who are self-administering asthma medication. This finding further supports the idea of applying directly observed therapy (DOT) of asthma medication by school nurses (Chapter 3, Section 3.4.3) which suggests that medication administration by school nurses will promote medication adherence and reduce health care service use (Harrington et al., 2018; Trivedi et al., 2018). The various responses related to medication administration suggest that efforts are needed to familiarise school nurses with local medication administration policies. However, our findings are not surprising, as a structured school medication administration policy does not exist in Oman. Appendix 8.1 presents a list of medications available in the school setting, while a school health supply list can be found in Appendix 8.2. It seems possible that these documents were perceived by the majority of school nurses as the medication administration policy, indicating a lack of awareness regarding this aspect. Another possible explanation for the lack of a medication administration policy is the fact that each student has a school health record stating their condition and the type and frequency of administered medication. However, it is important to bear in mind that medication administration practice in schools undergo constant change, and school nurses are not present in schools five days a week. It is interesting to note that this finding is similar to findings from a recent study in the US. Lowe et al. (2022) conducted a systematic review and meta-analysis to investigate medication administration practices in U.S schools and identified 17 relevant studies. The study found that medication administration practices in U.S. schools varied widely, with variability in policies, procedures and training across different states, school districts and at individual schools. Additionally, there was a lack of standardisation and consistency in medication administration practices, with many schools lacking clear policies and procedures for medication administration (Lowe et al., 2022).

Another American qualitative study by Lineberry *et al*. (2018) describes the administration of authorised asthma medication such as albuterol as a function of school nurses. It is worth noting that schools in Oman have stock asthma rescue medication in the form of a nebuliser puff, yet no written policies on its administration exist. Administering medication in a non-hospital setting raises issues that need to be addressed with written policies and procedures (Maughan et al., 2018). These include documentation of medication prescriptions and accepted labels, who can administer the medication and how. Previous literature confirms that when policies are in place, stock asthma rescue medication may be administered in emergencies by school nurses or trained school personnel without staff fearing legal liability (O'Rourke et al., 2020).

With the unacceptable low use of preventive asthma medication among children in Oman (Chapter 2, Section 2.6), the school system also needs to develop policies that indicate when students are allowed to carry and self-administer their asthma medication. With the absence of full-time school nurses in Omani schools, other school staff members, such as teachers or administrators, may be responsible for administering medications to students. However, there may be concerns about their knowledge, skills, and ability to safely and effectively administer medications. The lack of medication administration policy can have significant implications for school nurses. Without clear policies and procedures, school nurses may face challenges in ensuring that medication administration is conducted safely and effectively. Furthermore, a lack of medication administration policy can create legal and liability issues for schools and school districts, particularly if medication errors or adverse events occur. Having clear policies and procedures in place can help to mitigate these risks and ensure that medication administration is conducted safely and effectively in schools.As key health care providers, school nurses should work together with stakeholders to structure, inform and implement the development of policies related to asthma management in schools. Stakeholders can include parents, teachers, school administrators, healthcare providers, community organisations and local government officials. Early identification and intervention is the first benefit of such collaboration. School nurses who work closely with teachers and parents can help identify students who may be at risk for asthma or who may be experiencing symptoms. School nurses can also collaborate with stakeholders to conduct needs assessments to identify the prevalence and impact of asthma in the school community. This information can be used to develop policies that address the specific needs of

the school community. A qualitative study in the U.S collected data through focus group and interviews from families, schools and health care providers involved in asthma care, including school nurses. The authors reported that school nurses' input was crucial in implementing new strategies for identifying and tracking students with asthma. Additionally, a needs assessment that included all stakeholders helped to determine the characteristics required for hiring asthma counsellors in schools (Gleason et al., 2016). Another qualitative study that was conducted in a large urban school district in the US explored the perspectives of stakeholders on communication involved in a school-cantered asthma programme. The stakeholders included school nurses, school administrators, parents of students with asthma and representatives from community organisations. School nurses were identified as key communicators who played a critical role in facilitating communication between parents, school administrators and healthcare providers. Furthermore, collaboration between school nurses and health care providers can facilitate advocacy efforts to secure resources and support for asthma management in schools. This can include advocating for additional funding, resources and training for school staff and students, as well as for policy changes at the local and state levels. McCabe (2020) discusses the advocacy role of school nurses, which involves working to ensure that students with asthma receive the support and accommodations they need to succeed in school. This includes advocating for students' needs with school administrators, teachers and other stakeholders, as well as providing information and support to families to help them navigate the complex healthcare and education systems (McCabe, 2020). Collaboration between school nurses and stakeholders can ensure that asthma-related policies are effectively implemented and evaluated. This can involve monitoring and assessing the impact of policies on student health outcomes and making adjustments as needed to improve the effectiveness of policy implementation.

Recent literature on school nurse workloads (Davis *et al*., 2019; Jameson *et al*., 2020) suggests that school nurses are doing their best to provide daily health services to students, but they do not have additional time to devote to policy development and implementation despite being an essential component of school nurses' role. When policies are formulated, there is a need for proper implementation to avoid discrepancies between what is stated in the policy and what is practiced. In a mixed method study by Volerman et al. (2020) inhaler carry and use among children at school was examined using both quantitative and qualitative data collection methods.

For the quantitative component, the researchers used a survey to collect data from parents of children with asthma who were attending elementary schools in a large urban school district. The survey asked about the child's asthma symptoms, medication use and inhaler-carrying behaviour. For the qualitative component, the researchers conducted semi-structured interviews with a subset of parents/guardians to gain a deeper understanding of their experiences with their child's asthma management at school, including inhaler carrying and use. In this study, parents described inconsistent policy implementation in schools as a barrier to inhaler self-carrying at schools. This was problematic for parents, because they also reported that when children self-carried their inhalers, they were more consistent in taking their medication when required. The lack of uniformity in the application of school policies related to asthma management and inhaler self-carrying leads to confusion and uncertainty among school nurses, parents, and students regarding the rules and regulations that govern the administration of medications at school. It can be difficult for school nurses to enforce policies that are not clear or consistent, which may lead to misunderstandings, non-compliance and potentially harmful situations for students with asthma (Volerman et al., 2020). When investigating the barriers encountered by school nurses regarding asthma management, Quaranta and Spencer (2016) reported a significant correlation between lack of school policies and contacting the health care provider about a child's condition. However, in the same study, only 6% of nurses reported that a lack of policies on asthma management impeded the asthma management care provided to students.

Delegation of tasks when school nurses are not available is another important issue regarding medication administration policy. It should be pointed out that delegation does not preclude the need for full-time school nurses in each school (Holmes, Sheetz, et al., 2016). Delegation of health services means providing health services by school personnel other than a registered nurse. It is noteworthy that almost all school nurses in this study did not delegate nursing actions like medication administration to unlicensed personnel. By contrast, the majority of school nurses in Calabrese's (1999) study delegated medication administration. According to the study, 88% of the school nurses reported that they administered medication to students with asthma, while the remaining 12% delegated this responsibility to other school personnel, such as teachers, health aides or administrative staff. Calabrese et al. (1999) did not provide further details on the specific staff members who were delegated the responsibility of medication

administration. It is important to note that the study was conducted over two decades ago, and there have been significant changes in the field of nursing since that time, especially in terms of nursing education and practice. As a result, some of the findings in the study may not reflect the current state of nursing practice and education, particularly with regards to asthma management. The NASN advises that delegation is beneficial when the five rights of delegation exist: the right task, the right circumstances, to the right person, with the right directions and communication and under the right supervision and evaluation (NASN,2022). An US qualitative study explored the role of school nurses in medication administration and the challenges they face with delegation legislation using focus group interviews (Lineberry et al., 2018). The study concluded that delegating school health service delivery to school staff is an important part of the role of school nurses, and having a national standard regarding delegation can provide more visibility to the role of school nurses. The role of a school nurse in delegation can vary depending on the specific school and its policies. However, in general, a school nurse may be responsible for delegating certain tasks to other staff members, such as trained health assistants or schoolteachers. Some of the tasks school nurses may delegate to other staff members can be providing basic first aid to students who have minor injuries or illness and providing asthma education to students, parents and staff members. School nurses can delegate such tasks to a trained health educator or another qualified staff member. They can also delegate the task of administering asthma medications, such as inhalers or nebulizers, to trained and competent staff members. The school nurse must ensure that staff members are knowledgeable about the student's specific asthma medications, dosages and administration procedures (NASN, 2022). The role of school nurses in delegation is likened with their role in health education. When delegating tasks related to asthma care, the school nurse should educate the delegate about the assigned task to ensure that the delegate is properly trained and competent.

The findings of the current study support the role of school nurses in health education. In this study, school nurses identified educating school students regarding asthma management and exacerbation prevention as one of the most reported asthma-related functions. Health education is also a major role of school nurses, and through health education, school nurses can support safe and effective medication administration (Hoekstra et al., 2016; McClintock, 2018). The health teaching role of the school nurse encompasses a broad range of responsibilities, from

educating school staff to providing health education to students with asthma. School nurses can educate school staff and teachers on how to administer asthma medications, such as inhalers or nebulisers, to students in an emergency situation. By providing training on the proper administration techniques and signs of an asthma exacerbation, school nurses can help school staff and teachers feel more confident in their ability to respond to an emergency situation. Furthermore, the school nurse's role extends to educating students with asthma about the importance of taking their medications as prescribed and how to use their inhalers or other devices correctly. By providing students with clear instructions and information about their medications, school nurses can help to improve asthma management and reduce the risk of exacerbations. Moreover, school nurses can use health education strategies to help students with asthma understand why they need medication, how it works, and how to use it safely. GINA guidelines encourage the integration of asthma education into all aspects of care and the involvement of all health care professionals at multiple care points (GINA, 2022). The school setting offers a unique opportunity to provide asthma education and management interventions to schoolchildren (Nadeau & Toronto, 2016). Until recently, students with asthma either had to take their inhaled medication where a school nurse could supervise them, or an adult family member needed to manage the issue when the school nurse was not available. Because schools in Oman do not have full-time nurses, this necessitated an extension of the services that could be delegated to unlicensed personnel like schoolteachers.

School nurses are often responsible for a wide range of tasks beyond nursing duties. School nurses in this study reported additional non-nursing activities being assigned to them, such as regular assessments of school cafeterias and recreational areas as well as regular check-ups of drinking water. By contrast, the previous work of Huss *et al*. (2001) reported that school nurses performed few non-asthma-related nursing activities. In agreement with our findings, school nurses in Qatar reported that evaluating the school environment for health and safety was one of their roles (Layla et al., 2013). Performing non-nursing activities can increase the workload of school nurses, which may limit the time and resources they have to devote to nursing tasks such as medication administration, health assessments and care planning. The fact that the average school nurse-to-student ratio in Oman’s government schools is 1:1000 and given that each school nurse attends two schools per week, these non-nursing tasks can act as obstacles

for nurses to maintain a competent level of practice, as it increases their workload, which further impacts their delivery of care. Working in multiple schools seems to be commonplace among school nurses in other parts of the world. Linberry et al. (2018) reported that school nurses in the US also work in multiple schools, so proper training for non-nursing school staff allows students with chronic conditions to get the required health service without the presence of a school nurse. Based on the workload school nurses encounter and the absence of health assistants and national standards of delegation, it is not surprising that school nurses experience challenges to attending continuing educational programmes.

About half the nurses in this study reported attending an asthma education programme either over a year ago or in the past year. Alarmingly, some school nurses who never attended an asthma education programme reported encountering a student with asthma exacerbation once a month, and those who attended an asthma education programme over a year ago reported encountering a student with an exacerbation on a weekly basis. In response to this identified gap, actively seeking educational opportunities to advance their knowledge is a pressing need among school nurses. The literature reveals a lack of continuing education as one of the numerous obstacles to effective asthma management. The lack of continuing education for school nurses is a significant issue that can impact the quality of asthma care provided to students. In their a qualitative study using semi-structured interviews with school nurses in the US, Quaranta and Spencer (2016) found that inadequate training and education, particularly the training related to asthma emergency situations, was a barrier to effective asthma management at schools. In an American cross-sectional study of 500 school nurses, 49% (n = 245) had attended an asthma education programme during the previous year (Hillemeier et al., 2006). Calabrese et al. (1999) reported that 76% of the surveyed school nurses had not attended any asthma education in the past six months. Without access to ongoing education and training, school nurses may not have the knowledge and skills necessary to effectively manage the complex health needs of students with asthma. The lack of education and training for school nurses can also affect their ability to effectively delegate tasks because effective delegation requires the nurses to have the necessary knowledge and skills to assess the task, identify the appropriate delegate and provide clear instructions and supervision (American Nurses Association, 2012). Therefore, the nurse's knowledge and understanding of delegation

principles and their role in the delegation process are essential for effective delegation of nursing tasks. A school nurse who lacks training in administering medication via a nebulizer or managing students with severe allergies may not feel comfortable delegating these tasks to other personnel, even if the personnel are qualified.

When asked about issues that they perceive as essential in an asthma education programme, school nurses in this study reported the following topics: current asthma guidelines, medication administration and medication delivery devices, age-appropriate teaching materials, assessment and monitoring and exacerbation management. The responses of school nurses also reflected their own desire for additional education regarding inter-professional collaboration in asthma management in schools. Similarly, a previous cross-sectional study assessing asthma management in primary schools found that 57% of school nurses reported a need for additional education regarding current asthma guidelines, medications and triggers (Kielb et al., 2007). Unfortunately, many school nurses do not have access to continuing education programmes, either due to a lack of funding or inadequate support from their school districts. This can result in a lack of professional development opportunities, limited access to new and innovative approaches to healthcare and reduced capacity to address the complex health needs of students.

In order for school nurses in Oman to be a valuable source for children's health and well-being, they must continue developing their skills and direct their efforts appropriately. It is unfortunate that none of the school nurses in this study are members of any school nurse association. To promote themselves as professionals in the field of school nursing, school nurses should consider joining national and international school nursing organisations (Nadeau & Toronto, 2016). Similar to school nurses in other parts of the world, the nurses in this study need to stay up to date with current practices in asthma care, particularly with the vast majority of them reporting that they do not follow any specific asthma guidelines when caring for a child with asthma. Previous studies in the US suggested that school nurses may not follow or be aware of some of the asthma care guidelines (Hanley Nadeau & Toronto, 2016; Quaranta & Spencer, 2016), indicating a possible lack of knowledge regarding current guidelines (Seger, 2018). As noted in Chapters 3 and 4, educating school nurses about asthma has yet to be well articulated in terms of structure. There is no established framework or set of standards for educating school nurses. This study shows that the role, functions and educational needs of school nurses in Oman

are similar to those in other parts of the world and are worth investigating because, as shown in Chapter 3, asthma education for school nurses translates into improved child health outcomes. Through education, the expansion of roles for school nurses, including providing direct care to students, communicating between the school, families and health care professionals and promoting health through health education, can be facilitated.

The need for adequately trained school nurses is undebatable in light of the high prevalence of asthma among schoolchildren in Oman and the inability of this age group to self-manage asthma exacerbation. The existence of standardised asthma care guidelines in each school is a form of education by itself. Nevertheless, education interventions for school nurses remain scarce. Current findings suggest that changes by multiple stakeholders (i.e., school nurses, school personnel, primary care providers, policy makers) are needed to enhance asthma care at schools and promote access to continuing education. Thus, even when an intervention is primarily school nurse-focused, policy formulation and interventions that target multiple providers of asthma care are essential.

8.3 The Impact of SNAEP on the Knowledge and Self-Efficacy Levels of School Nurses in Oman

The impact of SNAEP on school nurses' overall asthma knowledge and self-efficacy levels was assessed using the two questionnaires (Chapter 6, Section 6.8.2). As discussed in the previous section, Phase 1 of this study identified the need for education around the current asthma guidelines, with particular attention focused on asthma exacerbation prevention and management. According to the needs assessment, school nurses reported a lack of asthma continuing education programmes, frequent encounters with asthma exacerbation at schools, uncertainty regarding medication administration policy and limited use of PFM. Based on the identified needs, knowledge and self-efficacy levels were measured at four data collection time points: before the implementationof the programme, directly after the implementation, three months after the implementation and six months after the implementation.

8.3.1 Impact of SNAEP on School Nurses' Asthma Knowledge Levels

The study findings indicate that the knowledge level of school nurses at the three data collection time points after SNAEP is higher than their knowledge level prior to administration of the programme. The results also reveal that the questionnaire items regarding general asthma information, such as "*asthma can cause death"*, "*asthma is a chronic condition"* and "*asthma symptoms can be controlled with medication compliance and trigger avoidance*", were those with the most correct responses throughout the four data collection points. This is not surprising. As a result of their education and practice, school nurses are likely to have a basic understanding of asthma.

Prior to SNAEP, questionnaire items related to medication and medication delivery devices, particularly those regarding inhaled steroid medication and PFM use, were the items with the fewest correct responses. It has been observed that school nurses do not recognise the main purpose of PFM as a monitoring device for asthma symptoms rather than as a diagnostic device (Chapter 2, Section 2.3.3.1). Therefore, it is not surprising to observe such responses, as almost all school nurses in Phase 1 reported that they do not use PFM at their schools. However, the use of PFM should alert the nurse that impending asthma exacerbation might occur, and previous studies have supported the positive effect of education regarding PFM use by school nurses (Erickson et al., 2006; Winkelstein et al., 2006).

It was observed in this study that few correct responses were provided to the questionnaire item related to worsening of asthma symptoms without noticing a change in breathing. This reflects the need for education regarding the early identification of symptoms. This point is particularly relevant for exacerbation prevention, as school nurses' ability to provide early identification of worsening symptoms can lead to prompt intervention and prevent severe asthma exacerbations (CDC, 2019b). Although the use of PFM by school nurses is not widely examined in the context of school nurses' knowledge, its use by schoolchildren has been emphasised extensively, with research indicating the need to adopt PMF as a self-management skill for schoolchildren with asthma (Isik et al., 2020). School nurses are in a position to teach PFM skills to students. A 12-week RCT investigated the effectiveness of a school nurse-led asthma intervention on self-management skills among school-aged children. One component of the intervention was the use of a PFM. The researchers found that the use of a peak flow meter was significantly associated with improved self-management skills ($p < .001$), including improved asthma symptom

recognition, increased use of asthma action plans, and increased use of rescue inhalers. The study suggests that the use of peak flow meters can be a useful tool in promoting the self-management of asthma in school-aged children (Isik et al., 2020).

Immediately after the administration of SNAEP, there was observed improvement in responses to almost all questionnaire items, with noticeable improvement regarding the dry powder inhaler technique, reflecting that skill demonstration was beneficial. The use of a spacer with the dry powder inhaler allows for better disposition of medication into the lungs, and this was clearly explained and demonstrated in the practical part of the programme. However, items related to inhaled steroid medication, such as "*the purpose of steroid asthma medication*", and PFM use, such as "*peak flow meters are used to determine if someone has asthma*", netted the greatest number of incorrect responses, even though scores were better than those before the administration of SNAEP. It was observed that it is common for school nurses to be confused when distinguishing between steroid and bronchodilator indications. While steroids are used to reduce lung inflammation, the rescue inhaler bronchodilator is used to rapidly widen airways and prevent bronchospasms (Chapter 2, Section 2.3.4). The lack of knowledge regarding this aspect of medication and PFM remained constant at Time 3 and Time 4. A possible explanation for this may be the lack of adequate supplies of PFMs, inhalers, spacers and medications. The literature reported a lack of resources as one of the top barriers to effective asthma management (Nadeau & Toronto, 2016; Quaranta & Spencer, 2016; Ebell et al., 2019a; Pappalardo et al., 2019). For example, in a recent cross-sectional study that assessed the perception of school nurses in managing asthma at schools, only 15% (n = 26) of school nurses reported the availability of PFM in their school, and only 5% (n = 9) reported the availability of a rescue inhaler (Gibson-Young et al., 2022). The shortage of equipment and medication for governmental schools in Oman is similar to that reported in the literature. The inspection checklist for schools (Appendix 8.1) indicated that a nebuliser puff was the only asthma-related item provided to schools. This calls for examining relevant laws and regulations to allow school nurses to administer a bronchodilator.

Arguably, it is worth exploring the ability of school nurses to actually administer asthma medication and use the delivery devices. While there is increasing evidence that education improves asthma knowledge among adults, this theoretical information may not be easily

retained, indicating the need for ongoing continuing education. In addition, the lack of knowledge acquisition and retention related to medication could be attributed to the didactic lectures. As discussed in Chapter 4, there is no coherent body of knowledge regarding the methods for asthma education and training for school nurses (Section 4.6.3), and previous studies reported lectures with or without visual demonstration as common teaching methods to educate school nurses about asthma (Chao et al., 2003; Frankowski et al., 2006; Winkelstein et al., 2006). Putman and Pinto (2011) used active learning methods in which school nurses interacted with the instructor in a live web-based programme. The intervention phase of the current study included a demonstration and a return demonstration of medication delivery devices, but the types of medication and their indications were explained to school nurses in lecture form, which may explain the lack of retention of pharmaceutical information.

In an RCT, Cheng et al. (2022) argued that learning through a game-based approach had a greater potential to transfer information from short-term to long-term memory among nursing students who were learning about medication indications and mechanisms for action. The authors reported that either board games or lectures could increase medication knowledge scores and that memory could be strengthened through board game play as a teaching method (Chang et al., 2022). Gamification can be used to engage and motivate school nurses in their learning. This approach involves using game-like elements such as points, badges and leader boards in non-game context to incentivise learning and make it more enjoyable. It is commonly used in education, training and other areas to enhance motivation, learning and retention (Nah et al., 2014). It is worth mentioning that in the study by Chang et al. (2022), nursing students were able to retain knowledge about medications for at least one month, but long-term retention was not assessed. This finding is similar to a systematic review (20 studies, n = not reported) which concluded that, when teaching pharmacology to nursing students, the least effective methods to improve the acquisition of medication knowledge were problem-based learning, a flipped classroom and lectures. Instead, interactive teaching strategies were found to be more effective in teaching pharmacology (Gill et al., 2019). Considering the restrictions in place due to the COVID-19 pandemic at the time of the intervention implementation, it was difficult to have several players engaged in a board game together; instead, other interactive methods were employed while maintaining social distancing.

By the end of this study, school nurses' knowledge of quick-acting inhaler and dry-powder inhaler use had declined, alongside deteriorated recall of skills. A common reason for incorrect inhaler use is confusion about proper use (Alismail et al., 2016). An improper inhaler technique can cause insufficient drug delivery, leading to less treatment effect and increasing the risk of asthma exacerbation (GINA, 2022). Therefore, inhaler skill training and routine checks at every visit are essential (GINA, 2022) and can deteriorate as soon as one month after a visit among children with asthma (Chapter 3, Section 3.5.1; (Ismaila et al., 2013). In addition to the lack of exposure to inhaler devices, various technical changes in inhaler designs have made it challenging even for health care professionals to keep up with the correct inhaler techniques (Alismail et al., 2016). Most education about inhaler techniques is based on single training sessions that, in most cases, are not followed up with refresher courses (Self et al., 2007; Alismail et al., 2016). Another possible explanation for incorrect inhaler use could be the unavailability of the device as a result of their relatively high cost, alongside health care professionals' lack of knowledge regarding the correct technique for inhaler use. These conditions may justify the lack of retention of medication delivery device skills among school nurses. Simulation-based training can be used to provide a safe and controlled environment for school nurses to practice using various inhalers and delivery devices. This approach allows them to gain hands-on experience and build confidence in their skills.

It is worth mentioning that the current study used a one-off physical demonstration of inhaler technique and a return demonstration during the intervention. The attainment of skills was measured theoretically by the knowledge questionnaire three and six months after the programme, which assessed whether the participants learned how to properly demonstrate the use of an inhaler. Multiple studies have found that a follow-up physical assessment of skills with a reinforcement of education is essential for school nurses' long-term retention of skills and to ensure that they are performing assessments accurately and consistently. Although previous literature on the demonstration of inhaler techniques among health care professionals indicated that correct inhaler use could be achieved in a single educational session, the skill was not maintained for more than four months (Resnick et al., 1996; Jackevicius & Chapman, 1999; Basheti et al., 2008; Basheti et al., 2014). The frequency with which school nurses' practical skills need to be refreshed requires further investigation, but remote training and assessment

were found to be successful and feasible in a recent study of a multi-modal education programme to enhance pharmacists' clinical knowledge of asthma and practical skills in using asthma delivery devices. Pharmacists participating in remote training were able to demonstrate optimal device technique, indicating the efficiency of remote skills assessments (Serhal et al., 2022). This finding can be relevant to school nurses. Interactive e-learning modules can be developed that allow school nurses to learn at their own pace and provide immediate feedback on their performance. These modules can include videos, animations and interactive quizzes to reinforce learning.

Regarding asthma knowledge and its relationship with demographics, this study found no significant relationship between asthma knowledge level and school nurse demographics. Similar to the current study, Quaranta (2013) reported no statistically significant relationship between asthma knowledge and years of experience in school nursing, nurses' educational level, or school location. Ramos et al. (2014) highlighted the education level of school nurses and its influence on the scope and quality of care provided to students with asthma. They found that rural school nurses were less likely to hold a bachelor's degree and less likely to have attended a continuing education programme. They argued that school nurses with a higher education level provide more integrative care to students. This brings us to the question of what shapes asthma knowledge beyond the professional education the school nurse has received. School nurses might acquire asthma knowledge in several ways, from basic education, clinical practice and ongoing education to cultural and personal beliefs (Seger, 2018). School nurses attending specialised asthma training programmes that have experience working with students with asthma and access to up-to-date information and guidelines are expected to have better baseline asthma knowledge. A combination of education and training using innovative strategies, experiences and resources can shape school nurses' asthma knowledge. Examples of resources that can shape this knowledge include asthma guidelines that the school nurse can refer to, online webinars and workshops and professional networking opportunities, such as membership in national and international school nurse associations.

8.3.2 Impact of SNAEP on School Nurses' Self-Efficacy Levels

The National Association of School Nurses recommends that school nurses increase their confidence in asthma management by being able to early recognise signs and symptoms of exacerbation, having an asthma action plan for affected students in place, encouraging appropriate school policies and procedures, addressing environmental issues, providing asthma education for the school community and initiating and participating in school-based asthma programmes (NASN, 2017). The results of this study revealed higher self-efficacy scores for school nurses post-SNAEP at all four data collection time points, reflecting the significant positive impact of the programme on school nurses' self-efficacy. This study found that self-efficacy diminishes over time, but, by the end of the study, all mean scores on questionnaire items were significantly higher than the respective baseline mean scores, indicating that SNAEP was effective in improving school nurses' self-efficacy up to six months post-intervention. These findings are similar to those of Winkelstein et al. (2006), who reported increased self-efficacy among school nurses and improvement in PFM, medication delivery devices, medication administration and communication after their attendance at an asthma education workshop.

The questionnaire items related to communication between the school nurse and the student's health care provider revealed the greatest self-efficacy throughout the study period. School nurses reported feeling comfortable contacting health care providers to discuss any concerns. However, their confidence in contacting the child's parent diminished over time. Quaranta (2013) and Pappalardo et al. (2019) found a lack of communication between the school nurse and the health care provider to be a challenge to effective asthma management, and Svavarsdottir et al. (2012) indicated that reaching health care providers during school hours is difficult and time-consuming. This demonstrates the importance of having an asthma action plan—a written form of communication between the school nurse and the health care provider—for each affected child (Chapter 2, Section 2.3.4.1.1.2). Given that phone calls may be not be efficient during busy clinic days, and to bridge the communication gap between school nurses and health care providers, an electronic platform such as interactive electronic health records may provide a solution (Pappalardo et al., 2019).

The questionnaire items with the lowest self-efficacy at the four data collection time points were items related to medication administration, PFM use and dry powder inhaler technique,

mirroring those items from the knowledge questionnaire. This finding supports previous research that found that, despite education and instruction in the use of PFM, school nurses reported a lack of self-efficacy in the use of PFM and medication delivery devices (Chao et al., 2003). The finding further highlights the need for continuing education and training to refresh and enhance the school nurses' knowledge and skills in asthma medication and delivery devices. Furthermore, the study underscores the importance of regular follow-up assessments to improve school nurses' self-efficacy, particularly in areas where knowledge gaps were identified (Section 8.3.1). This highlighted the same issue indicated in the knowledge questionnaire stating that, when nurses are unfamiliar with a device due to lack of resources or training, they are less likely to feel confident using it. Bandura's theory suggests that self-efficacy, or an individual's belief in their ability to perform a specific task, is influenced by their past experiences, knowledge, and skill level (Bandura, 1977). In the context of asthma management, a school nurse who has a strong knowledge of asthma medications and delivery devices may have a stronger sense of self-efficacy in administering these treatments to students. By addressing knowledge gaps and providing continuing education and training opportunities, school nurses may improve their self-efficacy and ability to effectively manage asthma in school settings. These results may help us understand the association reported in the literature between asthma knowledge and asthma self-efficacy.

There is limited available research that examines the relationship between knowledge and self-efficacy in the context of school nursing. However, exploring the research conducted on the topic among health care providers offers some insight, as school nurses are providers of health care. While Wu and Chang (2014) indicated that nurses' self-efficacy is separate from their knowledge but has a major impact on the care they provide, the relationship reported in most studies between asthma knowledge and self-efficacy revealed that these issues are interdependent and positively related. This study found a strong positive correlation between school nurses' asthma knowledge and self-efficacy levels at Time 1 before the SNAEP intervention and a moderate positive correlation immediately after SNAEP. Additionally, school nurses with greater knowledge demonstrated a higher level of self-efficacy. This result is in agreement with the findings of Quaranta (2013) and Seger (2018), which revealed a moderate positive correlation between knowledge and self-efficacy among school nurses.

These studies support the notion that school nurses with higher levels of asthma knowledge are more likely to engage in asthma care, and school nurses with higher levels of self-efficacy are more likely to take a proactive role in managing students with asthma. According to Borgmeyer et al. (2005), school nurses with good self-efficacy are more likely to perform a respiratory assessment of students with asthma, use a PFM and administer preventive asthma medication as needed (Borgmeyer et al., 2005). Other studies reported that providing asthma education to school nurses promotes their self-efficacy, leading to better engagement in asthma care (McCabe et al., 2021) that is manifested by a higher use of PFM, more frequent assessment of symptoms and improved provision of asthma education to the school community (Erickson et al., 2006).

Another important finding is that school nurses exhibited lower self-efficacy in managing asthma exacerbation without the need to send the child to the emergency room. This was evident at the four data collection time points. Even with the presence of basic asthma knowledge, school nurses reported low self-efficacy when independently responding to children with an exacerbation. A possible explanation for this is that school nurses in Muscat have easy access to health care centres at which primary care providers are usually available. Furthermore, they may have not experienced an opportunity to independently manage asthma exacerbation symptoms, which may be beyond their scope of practice as school nurses. However, as the first line of defence in addressing the health needs of students, school nurses have a critical role in managing exacerbation, and these nurses should be able to identify exacerbation signs and symptoms at an early stage. If a student is experiencing an exacerbation, it is the responsibility of the school nurse to provide the prescribed medication and manage the symptoms while communicating with the student's health care provider and family as well as school staff. A similarly low level of self-efficacy was identified in a study by Ugalde et al. (2018), whose cross-sectional study aimed to assess the emergency preparedness of school nurses in the United States. Most school nurses in the study (77 %, n =154) reported having students with severe asthma, but only 25% reported having confidence in their ability to manage asthma exacerbation despite the presence of an asthma emergency plan in the school (Ugalde et al., 2018). The presence of an asthma emergency plan is a positive step towards improving asthma management in schools. However, the low level of confidence among school nurses in managing asthma

exacerbations despite the presence of these plans suggests that there may be gaps in training and education for school nurses that needs to be addressed. Simulation-based training is a teaching method that can be adopted when teaching nurses how to respond to exacerbation. A recent prospective observational study indicated that prior exposure to simulation-based training improved medical students' skills in managing asthma exacerbation performance in a simulated asthma exacerbation scenario. The students who had received prior simulation-based training had significantly higher scores in terms of their performance in asthma exacerbation simulation compared to those who had not received such training (Liu et al., 2022). However, the technical infrastructure and financial aspect may limit the adoption of such strategy.

It is important to note that if the student experiencing severe asthma exacerbation is suffering from chronic respiratory failure that requires ongoing treatment and monitoring or is having uncontrolled asthma with frequent exacerbation, it may be beyond the scope of practice for the school nurse to manage their exacerbation care at school. Therefore, it is essential to train school nurses to recognise when students' symptoms are beyond their scope of practice and when it is necessary to seek medical assistance. This is a clear and compelling indication of the importance of having a clear scope of practice for school nurses. As discussed earlier, Oman lacks any written documents regarding school nurses' scope of practice. A clear scope of practice ensures that school nurses are aware of their areas of expertise and where they need further education and understand when to seek assistance. This knowledge ensures that students with asthma receive consistent, safe care and support. In addition to a clear scope of practice, various strategies can be adopted to increase school nurses' self-efficacy in asthma exacerbation management, such as providing easy access to resources, ensuring ongoing education and training and collaborating with other health care professionals. As communication with health care providers was one of the highest-ranked items in reported self-efficacy, school nurses in this study seem to have no obstacles when contacting primary care providers.

Some evidence suggests a link between school nurses' self-efficacy and their demographics, a finding that was not evident in the current study or in research by (Fisher, 2006). However, Quaranta (2013) found a positive, though weak, correlation between school nurses' years of experience and their self-efficacy in managing asthma exacerbation. As the number of years in the field increased, so did the self-efficacy scores ($r = .168$, $p = .001$). The study also found that

full-time school nurses had higher mean self-efficacy scores (mean = 65.2, p = .29) compared to part-time school nurses (mean = 62.7), indicating that full-time nurses have a higher level of competence. This is an important issue to consider, especially in Oman, where there is a shortage of school nurses and each school has a nurse on campus only two days a week.

8.4 Summary

Based on this study, it is evident that SNAEP was well received and boosted school nurses' confidence; in fact, its impact was positively maintained up to six months post-intervention. Nurses' lack of self-efficacy in PFM use and the use of medication delivery devices is in line with their lack of knowledge regarding these aspects, indicating the need to reconsider the ongoing training opportunities and teaching methods used when delivering education.

It is essential for school nurses to have a solid understanding about asthma and feel confident in their ability to manage students with asthma. Ongoing education and training can help to build and maintain this knowledge, ensuring that students can receive the care they need at school. It is essential to prioritise the continuing education of school nurses and ensure that they have access to ongoing training and professional development opportunities. This includes providing funding for continuing education programmes. By investing in the ongoing education of school nurses, we can improve the quality of healthcare provided to students and promote better health outcomes for all.

School nurses' knowledge of asthma management is important because it directly affects their ability to identify and respond to asthma symptoms, provide appropriate treatment and communicate with families and other healthcare providers. A lack of knowledge can result in poor outcomes for students with asthma. However, although lack of knowledge and health literacy are consistently linked to negative outcomes, simply increasing knowledge does not guarantee better outcomes unless it is accompanied by improvements in other important aspects, such as attitude or self-efficacy (Lavoie et al., 2008; Mancuso et al., 2010; Omachi et al., 2013).

When school nurses lack knowledge and self-efficacy in managing asthma exacerbations, there is a risk of delay or inappropriate treatment, which can lead to serious consequences. In contrast, when school nurses have a good understanding of asthma management and emergency

preparedness, they can help to prevent asthma exacerbations from escalating and ensure that students receive prompt and appropriate care. Having a defined and well-understood scope of practice for school nurses is crucial for various reasons, including ensuring student safety, increasing accountability among school nurses, providing uniform care, enhancing health outcomes and promoting growth and advancement in the field of school nursing.

Innovative teaching strategies, such as interactive e-modules, gamification, and simulation-based training, offer promising opportunities for enhancing the effectiveness of educational interventions aimed at teaching school nurses about asthma. These methods are known to engage learners, improve knowledge retention, and promote the development of practical skills in a safe and supportive learning environment. Therefore, adopting these strategies may facilitate the acquisition and application of knowledge and skills among school nurses, ultimately leading to better management of asthma in school settings. However, technical issues, cost and over-reliance on technology are possible drawbacks to consider.

Chapter nine: Conclusion and Study Implications

9.1 Introduction

This chapter provides an overall summary of the general conclusions based on the findings of this study. The key implications, recommendations and limitations of this study are also discussed.

9.2 Summary of the Main Findings

This study aimed to examine the impact of the School Nurse Asthma Education Programme (SNAEP) on school nurses' asthma knowledge and self-efficacy levels. To the best of my knowledge, this is the first study of its kind to explore the role, functions and asthma educational needs of school nurses in Oman. The uniqueness of this study lies in its contribution to the field of asthma education among school nurses. As the first study to assess the educational needs of school nurses regarding asthma in Oman, this research sheds light on educational and training gaps in the literature. Additionally, this study investigated the impact of an asthma education programme, which has not been done before in this country. Therefore, this research not only provides new insights into the educational needs of school nurses but also evaluates the effectiveness of an asthma education programme, which can be used to inform future interventions in this area.

The collective findings from the scoping review of the literature identified the need to develop continuing education programmes for school nurses based on their educational needs. Additionally, there is a scarcity of valid and reliable knowledge assessment tools, which has limited the rigor of studies in this field because it hinders the ability of researchers to accurately measure and evaluate the knowledge levels of school nurses. Based on the literature review, school nurses' knowledge and skill deficiencies were recognised as a barrier to asthma management.

Phase 1 of this study found that the role of school nurses in Oman is multifaceted and similar to that of their counterparts in other parts of the world. In line with the nursing profession's fundamental tasks, school nurses in this study prioritise providing first aid to students in need,

which is the most frequently performed nursing task. As asthma is a prevalent chronic condition among children, exacerbation management in schools is a critical form of first aid that school nurses must be equipped to provide. Therefore, understanding the educational needs of school nurses regarding asthma is essential in ensuring that they can effectively manage asthma exacerbations in schools and provide the necessary care and support to students.

Health education is a paramount responsibility of school nurses as it plays a crucial role in promoting student health and wellbeing. In Oman governmental school settings, where full-time school nurses may not be available, health education becomes even more critical, as it empowers students, parents and school staff to take an active role in maintaining their health and managing asthma and other chronic conditions. In this context, the role of health education intersects with the delegation role of school nurses. As part of their delegation role, school nurses must assess and evaluate the needs of students and delegate tasks to unlicensed personnel to ensure that all students receive the necessary care. However, effective delegation relies heavily on the knowledge and skills of the unlicensed staff. Therefore, the health education role of school nurses becomes critical in ensuring that the unlicensed staff have the necessary knowledge and skills to perform delegated tasks safely and effectively.

The results of this study provide evidence supporting the effectiveness of the School Nurse Asthma Education Programme in enhancing the asthma knowledge and self-efficacy of school nurses. The impact of such programmes was observed to be sustained up to six months post-intervention. However, it was found that education programmes should place particular emphasis on improving school nurses' knowledge and self-efficacy regarding asthma medication and delivery devices, as school nurses exhibited less competency in these areas. Moreover, innovative teaching approaches are needed to ensure knowledge retention, particularly for medication indication. Examples of these approaches include gamification, simulation-based learning and interactive E-modules. It is also recommended that follow-up refresher skill courses be provided to promote skill retention, as a single training session may not guarantee long-term skill retention beyond the study period.

Despite possessing basic knowledge of asthma management, the findings suggest that school nurses may lack the confidence to handle exacerbation effectively. By managing exacerbations

of asthma in schoolchildren, school nurses can help prevent serious respiratory complications and ensure the safety of these children while they are at school. The study findings highlighted the need to ensure that the scope of practice for school nurses is clear and that they are aware of their responsibilities and limitations in managing asthma in school settings.

9.3 Study Implications

The results of this study have important implications for policy, practice and service delivery, education and training and research.

9.3.1 Policy Implications

Findings from this study have highlighted that the role of school nurses is not clearly defined. There is an absence of a well-stated scope of practice, and the multiple non-nursing tasks are being assigned to school nurses. Additionally, school nursing policies are not clearly formulated, with no clearly defined medication administration policy. Findings also highlighted the need for a well-formulated policy regarding asthma exacerbation management which addresses the following issues:

- Developing and implementing clear policies and guidelines (job description) outlining the roles and responsibilities of school nurses in collaboration with stakeholders (e.g., school administrators, healthcare providers, policymakers, educators, parents).
- Developing and implementing a clear medication administration policy outlining school nurses' role in medication administration and delegation.
- Developing and implementing a comprehensive training programme for new school nurses that covers the scope of their responsibilities, relevant policies and regulations and protocols for communication and collaboration with other healthcare providers and educators.
- Developing and implementing school-specific asthma exacerbation management guidelines.

- Developing and implementing a system for monitoring and evaluating the performance of school nurses and ensuring accountability for meeting established standards and expectations.

9.3.2 Implications for Practice and Delivery Service

Practice implications may include first recognising the educational needs of school nurses through ongoing assessment. Second, providing access to resources and reviewing the current procedures in place for medication administration and the management of asthma exacerbation in the school setting. Findings highlighted the need to:

- Establish ongoing formal educational needs assessments that include school nurses and other health care professionals like primary health care providers.
- Provide funding for asthma educational materials such as brochures, posters and videos that can support school nurses in teaching school staff about how to recognise and respond to exacerbation.
- Provide funding for asthma management devices, such as peak flow meters and spacers, that can help students manage their asthma symptoms. School nurses can use these devices to monitor students' asthma symptoms and help them use their inhalers correctly. School nurses can use an air quality monitoring device to identify potential asthma triggers in the school environment.
- Ensure that unlicensed personnel, such as schoolteachers or secretaries, who are tasked with the responsibility of administering medication at schools, have the ability, resources and necessary training and knowledge to effectively perform the task.

9.3.3 Education and Training Implications

The ability to provide optimal care for schoolchildren with asthma is dependent on having the requisite knowledge, as knowledge and skill deficiency was recognised in the literature as a barrier to asthma management (Chapter 4). This highlights the need for ongoing in-service education in asthma management for school nurses, other health care professionals and the greater community. The findings from this study emphasised that school nurses need to participate in continuing education to remain up to date regarding asthma management. The

study's exploration of the asthma educational needs of school nurses in Oman informed the development of nursing curricula and continuing education programmes that address these needs. The findings provided guidance for continuing education programmes for school nurses in Oman and highlighted the need to:

- Develop training programmes that address the identified gap in knowledge and skills of school nurses, including the appropriate use of medication and delivery devices and asthma management plans. Providing education and training that is tailored to the specific needs of school nurses in Oman will improve their confidence in managing asthma in schools and improve the quality of care provided to students.
- Implement ongoing education and training for school nurses to ensure that they remain up to date on best practices in asthma management and continue to provide high-quality care.
- Adopt innovative teaching strategies such as interactive e-modules, gamification and simulation-based training and offer promising opportunities for enhancing the effectiveness of educational interventions aimed at teaching school nurses about asthma.
- Incorporate asthma management education into nursing curricula to prepare nursing students for their roles as school nurses.
- Implement evidence-based practices that can improve asthma management in schools, such as providing education to students and families, and ensuring appropriate medication management.

9.3.4 Research Implications and Recommendations

The review of the literature (Chapters 3 and 4) indicated a lack of up-to-date needs assessment tools and lack of valid and reliable school nurse-specific assessment tools, which affects the rigor of the data collection tools. The scoping review also indicated a dearth of reporting regarding teaching strategies and methods. Detailed reporting of teaching strategies and methods is important for ensuring replicability, transparency knowledge dissemination and improvement in teaching and research practices. Areas of research that would benefit from further investigation include:

- The development and validation of up-to-date nurse-specific needs assessment tools
- The exploration of the effectiveness of teaching methods, techniques and procedures adopted for continuing education for school nurses. This is relevant for many childhood illness/conditions.

The unique cultural and environmental context of Oman may have significant implications for the health and wellbeing of schoolchildren, and research conducted within the country may be better equipped to address the population needs. Indeed, Oman has a young population with a large number of schoolchildren, and asthma is a prevalent health condition among this population (Chapter 2). Future studies should include a greater amount of school nurses, schoolchildren with asthma and caregivers, and should focus on:

- Baseline data on environmental triggers that are unique to the region, or cultural factors that influence the perception and management of asthma symptoms.
- Up-to-date national epidemiological studies to investigate asthma as a public health issue.
- Mixed method approaches to investigate barriers to asthma management in schools.
- The existence of school nursing policies, including school nursing scopes of practice and school nurse medication administration and delegation policies.
- A national audit investigating the school nurse: student ratio.
- An RCT examining the impact of the school nurse clinic on students' health outcomes and school attendance.
- Exploratory studies on entry-level requirements for school nurses in Oman to gather data on current hiring practices and regulations in the country and gaps or inconsistencies in the current system of hiring and training school nurses. There should be clearly established criteria for being a school nurse, such as an entry license.

9.4 Limitations of the Study

The study had a number of limitations, the most obvious being the sample size for the needs assessment in phase 1 and the intervention programme in phase 2. Given the country's vast geography, the inclusion of 1 governate and the subsequent small sample size may not have

fully captured the breadth of educational needs among school nurses in Oman, leaving the potential for unidentified gaps in knowledge or educational training needs. However, this could have been minimised as all governmental schools in Oman have a similar structure in terms of school nursing services and asthma management. In a highly populated area with a large number of governmental schools, the selection of Muscat Governate was considered appropriate for the study as it provided a representative sample of the population under investigation and allowed for the examination of the impact of the intervention.

Additionally, school nurses' needs assessment relied on self-reported data that reflected their personal experiences and needs. They may not have accurately recalled their educational needs particularly if they had not recently encountered a student with asthma or have not previously mange an exacerbation. As a result, their responses may not provide a comprehensive understanding of educational needs across the population of school nurses. Moreover, while efforts were made to provide clear guidelines and instructions for completing the questionnaire, there was no guarantee that participants followed these guidelines consistently. Additionally, the lack of direct observation during the data collection process made it challenging to assess the extent to which school nurses may have sought assistance or additional resources when completing the questionnaire.

The data collection and educational intervention occurred during the peak of the COVID-19 pandemic, which presented several challenges that impacted the study's implementation. School nurses were at the front line of managing the pandemic, which may have limited their availability and increased their workload, resulting in reduced response rates to surveys and restricted attendance at the educational intervention. Additionally, social distancing measures and other COVID-related restrictions limited the type of activities and interactions between school nurses during the educational programme, which may have impacted their ability to fully engage with the educational content.

Another limitation of this quasi-experimental study was the lack of a control group due to the risk of contamination between the intervention and control groups. The nature of the intervention made it difficult to prevent school nurses in the control group from receiving some exposure to the intervention. As a result, the absence of a control group limited the ability to

draw definitive conclusions about the effectiveness of the educational intervention. While the quasi-experimental design allowed for some comparison between the pre- and post-intervention data, the absence of a true control group made it challenging to rule out alternative explanations for the observed changes in knowledge or behaviour.

9.5 Conclusion

The originality of this study lies in its dual focus on identifying educational needs and evaluating the impact of an intervention, making it a valuable contribution to the literature on asthma education and management. Additionally, this study contributed to the development of evidence-based practices for managing asthma in school settings. Being geographically and culturally unique, this study provided new information about educational needs for school nurses in Oman, which enabled the establishment of their national profile and facilitated a comparison between countries.

This study highlighted the importance of addressing the educational needs of school nurses, who play a critical role in managing asthma in schoolchildren. The findings may help nursing educators and administrators to design and implement effective educational programmes that meet the specific needs of school nurses and improve their knowledge and skills in asthma management. Additionally, the findings of the study have the potential to inform the content, delivery methods and evaluation of education programmes, ensuring that they are effective and responsive to the needs of the target audience. Finally, this study can serve as a baseline model for future research conducted in nursing education in Oman and Middle East, specifically in the area of chronic disease management.

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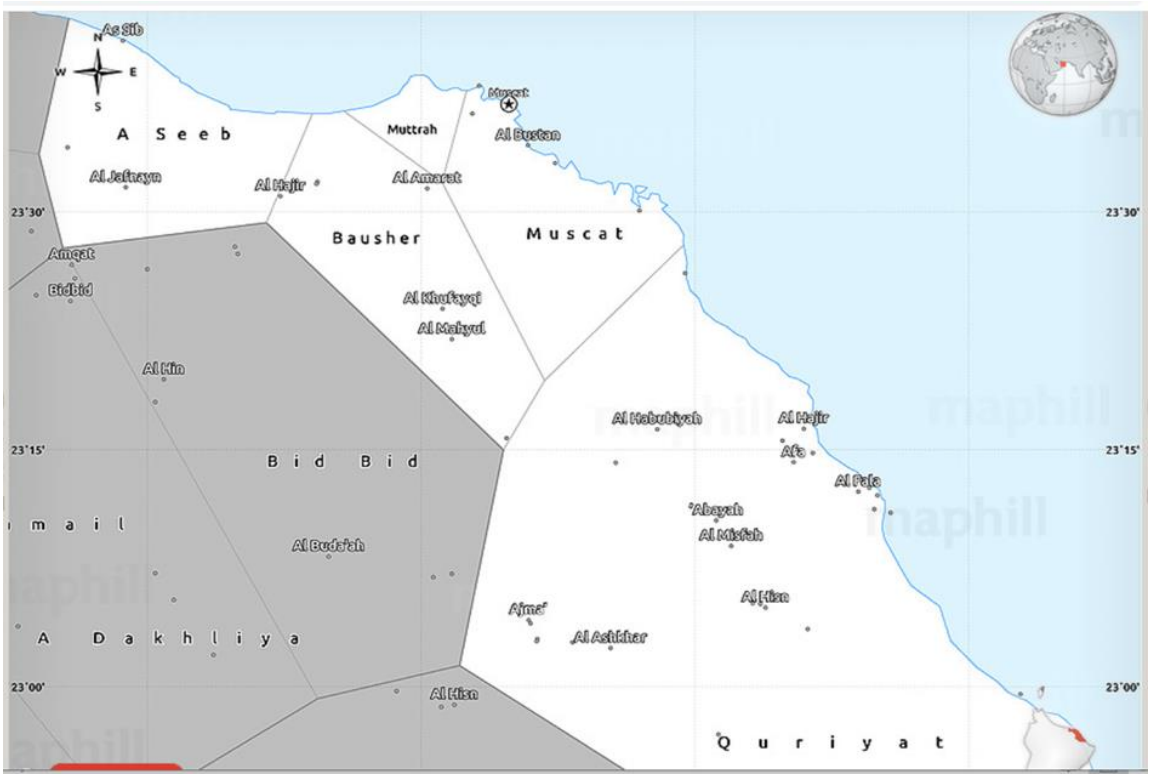
Appendix 6.1 Muscat Governorate Map

(Source:http://www.maphill.com/oman/muscat/simple-maps/gray-map/)



Appendix 6.2 Ethical Approval Trinity College Dublin

Zainab Al Kindi
School of Nursing & Midwifery,
Trinity College Dublin,
24 D'Olier St,
Dublin 2
8th April 2020

Ref: 2020105

Title of Study: Impact an Asthma Education Programme has on School Nurses' Asthma Knowledge and Self-efficacy Level in managing school children with Asthma.

Dear Zainab,

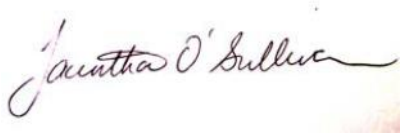
Further to a meeting of the Faculty of Health Sciences Ethics Committee held in April 2020. We are pleased to inform you that the above project has ethical approval to proceed.

This study has been ethically approved. We would advise you to seek review and comments on your DPIA from the DPO if required prior to study commencement'

As a researcher you must ensure that you comply with other relevant regulations, including DATA PROTECTION and HEALTH AND SAFETY.

Yours sincerely,

Prof. Jacintha O'Sullivan
Chairperson
Faculty Research Ethics Committee



Appendix 6.3 Ethical Approval, Oman

Sultanate of Oman
Ministry of Health
Directorate General of Planning and Studies

سلطنة عمان
وزارة الصحة
المديرية العامة للتخطيط والدراسات

Ref. : MoH/DGPS/CSR/PROPOSAL_ APPROVED/28/2020 ..... الرقم :

Date : 02.06.2020 ..... التاريخ :

..... الموافق :

Zainab Al kindi
Principal Investigator

Study Title: Impact of an Asthma Education Programme on School Nurses' Knowledge and Self-efficacy Level in managing school children with Asthma in Oman

Proposal ID: MoH/CSR/20/23479

After compliments,

We are pleased to inform you that your research proposal **'"Impact of an Asthma Education Programme on School Nurses' Knowledge and Self-efficacy Level in managing school children with Asthma in Oman'** has been approved by the Research and Ethical Review & Approval Committee, Ministry of Health.

On completion of the study, you are required to provide a copy of the final report within 2 months to the Centre of Studies and Research.

Regards,

Dr. Ahmed Mohamed Al-Qasmi
Director General of Planning and Studies
Chairman, Research and Ethical Review & Approval Committee
Ministry of Health, Sultanate of Oman.

Cc
Day file

SULTANATE OF OMAN - MINISTRY OF HEALTH

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مسقط ، هاتف: ٢٢٣٥٧٢٥٤، فاكس : ٢٢٣٥٧٢٦٠

Appendix 6.4 Letter of Invite

Dear school nurse colleagues

Asthma is one of the most common chronic conditions among students at school. Despite improved access to health care and advanced medical technology, asthma morbidity is increasing. School nurses are in a vital position to assist school students in managing their asthma and preventing complication. As such, it is essential that school nurses have continued access to asthma educational training, as we are a patient advocate in the first line of care, primary health care. The data you provide as school nurses will aid to understand the national school nurse role in daily asthma management of students with asthma. Furthermore, the information gathered will assist in establishing baseline data on your educational needs and plan accordingly.

I am currently doing a study to identify school nurses' asthma knowledge, roles, function, responsibilities and educational needs within a school setting. An asthma education programme will be delivered based on your needs assessment. This study is part of my graduate work at Trinity College Dublin, School of Nursing and Midwifery, Ireland.

If you are a school nurse (18 years or older) working in a governmental school at Muscat Governate, you are invited to participate in the research. Please take (approximately) 20 minutes to complete the enclosed questionnaire. The instructions are provided on the questionnaire. There are no risks to complying the survey tool for this research. The tools have been designed to ensure confidentiality and anonymity. Please do not write your name on any of the materials. For further clarification, you can contact the researcher: Zainab Al kindi by email: alkindiz@tcd.ie Phone number: +96897177112

Appendix 6.5 Participant Information Leaflet (Phase1: Needs Assessment Survey)

Name of Study: Impact an Asthma Education Programme has on School Nurses' Asthma Knowledge and Confidence Level in managing school children with Asthma

Site	**Oman, Muscat Governate**
Principal Investigator(s) and Co-Investigator(s) (insert names, titles and contact details)	**Mrs. Zainab Al kindi** **email ALKINDIZ@tcd.ie Phone#+96897177112** **Co-researcher: Dr Catherine Mc Cabe email: CAMCCABE@TCD.IE** **Co-researcher: Dr. Margaret Mc Cann email: mccannm1@tcd.ie**
Study Organiser/ Sponsor (if applicable)	**Ministry of Higher Education, Oman**
Data Controllers	**Trinity College Dublin (for research data)**
Data Protection Officer	**Data Protection Officer** **Secretary's Office** **Trinity College Dublin** **Dublin 2**

You are being invited to take part in a research study that is being done by Trinity College Dublin, Ireland by Zainab Al kindi at Ministry of Education, Oman.

Before you decide whether or not you wish to take part, please read this information sheet carefully. Ask Mrs. Zainab Al Kindi any questions. Don't feel rushed or under pressure to make a quick decision. You should understand the risks and benefits of taking part in this study so that you can make a decision that is right for you. You may wish to discuss it with your family or friends. This leaflet has five main parts: Part 1 – The Study

Part 2 – Data Protection

Part 3 – Costs, Funding and Approval

Part 4 – Future Research

Part 5 – Further Information

Part 1 – The Study

Why is this study being done?

- This study is planned to provide a baseline data on school nurses roles, functions, responsibilities, and educational needs in-relation to asthma management at schools. We are doing this study to provide evidence-based asthma education to school nurses to enable them to express their educational needs, communicate with families and other health care professionals, and to effectively manage asthma at school setting.

Why have I been invited to take part?

- You are invited to take part in this study because you are a school nurse working in a governmental school at Muscat Governate.
- All school nurses working at governmental schools in Muscat Governate are invited to participate.

Do I have to take part? Can I withdraw?

- You do not have to take part in this study. It is up to you to decide whether or not to take part. The participation in the study is entirely **voluntary**.
- If you wish to participate, you will be given this information sheet to keep, and you will be asked to sign a consent form.
- If you wish to participate, you are still free to withdraw without giving a reason for not taking part.
- You can withdraw from the study at any point of time, however, it will not be possible to remove your data from the research once it has been coded as we will not be able to identify your specific data. Yet, this does not affect your data protection rights. That means you will have the right to access your data, the right to modification, the right to erasure.
- If you wish not to participate, there is no adverse consequences. Your name will just be removed from participants' list. It won't affect your job evaluation, career development, and access to continuing education courses**.**

- If you wish to withdraw you can contact the researcher directly through phone number +96897177112 or via email: alkindiz@tcd.ie who will be able to organise this for you.

What happens if I change my mind?

- You can change your mind at any time by contacting Mrs Zainab Al kindi at +96897177112.
- The participation in this study is voluntary. You can withdraw from the study at any point of time even if the study has started. You won't have to give a reason for not taking part or for opting out.
- Withdrawal from the study will not in any way affect you job evaluation, career development, and access to continuing education courses.
- If you wish, you can ask for your data stored to be destroyed. If you request this, we will destroy all data that are still in our possession.
- We will no longer use or share your data for research from this point onwards. However, it will not be possible to destroy data already analysed before this time

How will the study be carried out?

- I , the researcher, will contact the General Director at Ministry of Education, Oman to identify and provide a list of governmental schools having school nurses at Muscat Govrenate.

- The list of eligible participants will be given to a gatekeeper (who was nominated by the General Director).
- The gatekeeper will approach the school principle to obtain permission to access the school. The gatekeeper will provide you with the invitation letter and participant information leaflet including brief information about the study and the researcher contact details to help you understand the research aim and to make a decision about participating.
- You and I, the researcher, sooner you notify me with your desire to participate, will sign the consent form.

- You, are asked to complete the enclosed needs assessment survey, sealed it with the provided envelope and return it to me, the researcher by keeing it in the school principle office.
- The Needs Assessment Survey will take approximately 20 minutes.

What will happen to me if I decide to take part?

- If you agree to participate, you will be invited to complete a national survey (Needs Assessment Survey) that explores school nurses' roles, functions and responsibilities in relation to asthma management at school setting.

What will happen to my Samples and Data?

- No biological samples will be obtained for the study.
- All the study data are about school nurses' roles, functions, responsibilities, and educational needs in relation to asthma management.
- All data including the consent forms will be stored securely in a locked drawer in a locked office at the researcher's home and will be uploaded electronically to the university research data storage for additional security purposes.
- Your personal data (demographic data) will be assigned a code, and your data will also be identified only by this number. Code keys will be shared only with the researcher supervisor.
- Your personal data will be kept for 7 years and then they will be destroyed according to the policies and regulations.

Are there any benefits to taking part in this research?

Taking part in this study will not directly benefit you. However, research performed with your information may help us to establish a baseline data on the current school nurses' asthma educational needs in Oman, which will result in implementing asthma training sessions that promote school nurses' knowledge and practice. By participating in this study, you are facilitating advance school nursing care in the country.

Are there any risks to me or others if I take part?

- There is no risk that a connection to your identity could be made. Attention will be taken to ensure the confidentiality of all data.
- All data will be pseudonymised, and no actual identification will be used. Your participation in the study will be kept confidential to the study team (Study supervisors and me).
- The researcher is the only one who will have access to the records. Any personal information such as your name will be removed in the final transcript

What happens if something goes wrong when I'm taking part in the study? ***(May not apply)***

It is unlikely that your participation in this study will cause harm.

Will I be told the outcome of the study? Will I be told the results of any tests or investigations performed as part of this study that relate to me?

- The results of the study will be published in a scientific journal and disclosed at a scientific conference/symposium. However, no information which reveals your identity.
- If you would like, you can receive a copy of the study results.

Part 2 – Data Protection

The following information should also be included as standard in Participant Information Leaflets, in order to ensure compliance with the 2018 Health Research Regulations.

What information about me (personal data) will be used as part of this study? Will my medical records be accessed?

- The gatekeeper (nominated by the General Director at Ministry of Education) will have access to the address of the school you are working in.
- Demographic data such as sex, age, educational level, years of nursing experience will be gained

What will happen to my personal data?

We are collecting and storing this personal information following the General Data Protection Regulation (GDPR) and Data Protection Act 2018 and Health Research Regulations 2018, which legislate to protect your personal information.

To protect your confidentiality and keep your data safe, the following steps will be taken:

- Personal information will be kept at a locked cabinet in private office at researcher's home.
- Your coded personal data will only be shared with my supervisor.
- Your names will be removed and pseudonymised when the results of this study will be published in a scientific journal and at a conference/symposium.
- Your coded personal data will be kept for 7 years and then they will be destroyed according to the policies and regulations.

Who will access and use my personal data as part of this study?

The researcher Mrs. Zainab Al Kindi will have access to the data. The supervisors Dr Catherine Mc Cabe and Dr. Margret Mc Cann will have access the pseudonymised data.

Will my personal data be kept confidential? How will my data be kept safe?

Your privacy is important to us. We take many steps to make sure that we protect your confidentiality and keep your data safe. Here are some examples of how we do this:

To protect your confidentiality and keep your data safe, the researcher had trained in data protection law, and the following steps will be taken;

- Documented information will be kept secured.
- Your information will not be used in future studies without obtaining your consent.
- Your name will be removed and pseudonymised when the results of this study will be published in a scientific journal and at a conference/symposium.
- The transferred of pseudonymised data to my supervisors will be through encrypted emails.

What is the lawful basis to use my personal data?

By law,[1] the researcher can use your personal information for scientific research [2] (in the public interest[3]). I will ask you to sign a consent form to use your data as a requirement of the Irish Health Research Regulation.

What are my rights?

You are entitled to:

- The right to access to your data and receive a copy of it.
- The right to restrict or object to the processing of your data if you decide to withdraw unless non-identifiable data are already analysed.
- The right to object to any further processing of the information we hold about you (except where it is de-identified).
- The right to have inaccurate information about you corrected or deleted.

[1] The European General Data Protection Regulation (GDPR)
[2] *Article 9(2) (j))*
[3] *(Article 6(1)(e)*

- The right to receive your data in a portable format and to have it transferred to another data controller.
- The right to request deletion of your data.

By law, you can exercise the following rights about your personal data unless the request would make it impossible or very difficult to conduct the research. You can exercise these rights by contacting the study researcher at alkindiz@tcd.ie/mobile No: +96897177112 or the Trinity College Data Protection Officer, Secretary's Office, Trinity College Dublin, Dublin 2, Ireland. Email: dataprotection@tcd.ie. Website: www.tcd.ie/privacy

Part 3 – Costs, Funding and Approval

Has this study been approved by a research ethics committee?

- Yes, this study has been approved by the Faculty of Health Science Research Ethics Committee, Trinity College Dublin. Approval was granted on [INSERT DATE].
- Furthermore, it is approved by the Research and ethics committee of Ministry of Education (DATE) and the Medical Research Ethical Committee at Ministry of Health on (DATE).
- The researcher will provide a progress report yearly (within 12 months period) for the Faculty Research Ethics Group at Trinity College Dublin. **Also, in case of a serious issue that is related to your protection, the researcher will report immediately to the Faculty Research Ethics Group at Trinity College Dublin**

Who is organising and funding this study? Will the results be used for commercial purposes?

Mrs. Zainab Al kindi is conducting this research as part of her PhD study at the School of Nursing and Midwifery, Trinity College Dublin. The Ministry of Higher Education in Oman funds this study. There is no relationship between the Ministry

of Higher Education and Ministry of Education and Ministry of Health. There is no conflict of interest between the funder and the study setting. The results of this study will not be disclosed for the Ministry of Higher Education and will not be utilised for commercial purposes.

Is there any payment for taking part? Will it cost me anything if I agree to take part?

No, we are not paying participants to take part in the study.

Part 4 – Future Research

Will my personal data and/or biological material be used in future studies? (May not apply)

Your personal data will be used for this study only. If your data will be processed for future studies, this will not happen without obtaining your consent.

Part 5 – Further Information

Who should I contact for information or complaints?

If you have any concerns or questions, you can contact:

- Principal Investigator: Mrs Zainab Al kindi, mobile No: +96897177112, e-mail: alkindiz@tcd.ie.

- Data Protection Officer, Trinity College Dublin: Data Protection Officer, Secretary's Office, Trinity College Dublin, Dublin 2, Ireland. Email: dataprotection@tcd.ie. Website: www.tcd.ie/privacy.

- Under GDPR, if you are not satisfied with how your data is being processed, you have the right to complain with the Office of the Data Protection Commission, 21 Fitzwilliam Square South, Dublin 2, Ireland. Website: www.dataprotection.ie.

Will I be contacted again?

If you would like to take part in this study, you will be asked to sign the Consent Form on the next page. You will be given a copy of this information leaflet and the signed Consent Form to keep.

Appendix 6.6 Consent Form

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

STUDY NAME: Impact an Asthma Education Programme has on School Nurses' Asthma Knowledge and Confidence Level in managing school children with Asthma **Centre ID:** **Identification Number for study:**

Consent Form

There are 3 sections in this form. Each section has a statement and asks you to initial if you agree. The end of this form is for the researchers to complete. **Please ask <u>any</u> questions you may have when reading each of the statements.** **Thank you for participating.** **Please <u>Initial</u> the box if you agree with the statement. Please feel free to ask questions if there is something you do not understand.**	
General	**Tick box**
I confirm I have read and understood the **Information Leaflet** for the above study. The information has been fully explained to me and I have been able to ask questions, all of which have been answered to my satisfaction.	
I understand that this study **is entirely voluntary, and if I decide that I do not want to take part, I can stop taking part in this study at any time without giving a reason**. I understand that deciding not to take part will not affect my job in anyway.	
I understand that my personal data may be looked at by the study researcher (Zainab Al kindi and her team) at her private office where it is relevant to the research. I agree that these individuals can access my records. I understand that all information will be kept private and confidential and that my name will not be disclosed.	
I understand that I **will not be paid for taking part in this study**.	

I know how to contact the research team if I need to.	
I agree to take part in this research study having been fully informed of the **risks, benefits and alternatives, which are set out in full in the information leaflet,** that I have been provided with.	
Data processing	**Tick box**
I understand that personal information about me, including the transfer of this personal information about me outside of the EU, will be protected in accordance with the General Data Protection Regulation.	
I understand that there are **no direct benefits to me** from participating in this study. I understand that **results from analysis of my personal information will not be given to me]**.	
I understand that **I can stop taking part in this study** at any time without giving a reason and this will not affect my future medical care.	

FUTURE USE OF INFORMATION		
RETENTION OF RESEARCH SAMPLES IN THE FUTURE [please choose one or more as you see fit]	**Y**	**N**
OPTION 1: I give permission for my personal information to be stored for *possible future research **related*** to the current study (Impact an asthma education programme has on school nurses knowledge and confidence) ***only if consent is obtained*** at the time of the future research and the research is approved by a Research Ethics Committee.		

Participant Name (Block Capitals) Patient Signature Date

Witness Name (Block Capitals) Witness Signature Date

To be completed by the Principal Investigator or the gatekeeper.

I, the undersigned, have taken the time to fully explain to the above participant the nature and purpose of this study in a way that they could understand. I have explained the risks and possible benefits involved. I have invited them to ask questions on any aspect of the study that concerned them.

I have given a copy of the information leaflet and consent form to the participant with contacts of the study team

Gatekeeper name

Title and qualifications

Signature

Date

| | |

3 copies to be made: 1 for participant 1 for PI and 1 for school records

Appendix 6.7 Needs Assessment Survey

The purpose of this survey is to find out what information school nurses need to care for those students who have asthma. Your answer will help to determine the current role of the school nurse in assessing and managing students with asthma. It will also help to identify educational needs in relation to this topic. There are no right or wrong answer. All of your answers will be kept confidential. Please answer Yes, or No where applicable. You may also write/type sentence answers where applicable.

Demographic Data

1- Age (state in years)	
2- Sex (select one)	a. Female b. Male
3- Name of School currently working in	
4- Years of experience in Nursing (state in years)	
5- Years of Experience in the field of School Nursing post qualification in nursing (state in years)	
6- Level of nursing education **You can circle more than one**	a. Diploma in nursing b. Bachelor's degree in nursing c. Master's degree in nursing d. Ph.D. degree in nursing e. Others (please state)
7- Do you have a Community/Public Health qualification (post nursing qualification)? (circle one)	a. Yes b. No If yes please give details

8. Circle the type of school you are working in and write the number of students you cover		
1. Elementary	1.a Number of schools ( )	1.b Total number of students ( )
2. Middle	2.a Number of schools ( )	2.b Total number of students ( )
3. Secondary	3.a Number of schools ( )	3.b Total number of students ( )

School Nurse Role/Function

9. How often are you at your school? Write the number of hours you spend at your school either per day or per week.

1. Elementary	1 .a Number of hours each day ( ) 1. b Number of hours each week ( ) 1. c Not assigned to an elementary school ( )
2. Middle	2 .a Number of hours each day ( ) 2. b Number of hours each week ( ) 2. c Not assigned to an elementary school ( )
3. Secondary	3 .a Number of hours each day ( ) 3. b Number of hours each week ( ) 3. c Not assigned to an elementary school ( )

10. What type of activities do you perform in a school setting? Circle all that apply

a. First aid	b. Immunization administration	c. Medication administration
d. Classroom health education	e. Individual health education	f. School-wide wellness promotion
g. support groups	h. Educating students on asthma management or attack prevention	i. Educating parents on asthma management or attack prevention
j. Educating teachers on asthma management or attack prevention	k. Educating students on the use of asthma medication delivery devices (Inhalers, Nebulizers)	l. Educating parents on the use of asthma medication delivery devices (Inhalers, Nebulizers
m. Educating teachers on the use of asthma medication delivery	n. Individualized health plan development/implementation	o. Development of emergency plans

devices (Inhalers, Nebulizers)		
p. Development of a fire evacuation plan for impaired students.	q. Development of classroom modifications for students with health problems.	r. Contacting parent to pick up a sick child
s. Transport of sick child to home or emergency department	t. In-service presentations for staff	u. In-service presentations for family
v. Others (please state)		

Medication Administration Policy

11. Does your school district have a medication administration policy?

a. Yes	b. No	c. Not sure

12. Are students permitted to self-administer asthma prescription medication in your school? (if no go to question 14)

a. Oral	1. Yes 2.No
b. Inhaled	1.Yes 2.No

13. If yes, do you supervise asthmatic students who are self-administering medication?

a. Yes	b. No

14. Are students permitted to self-administer non-asthma prescription medication in your school?

a. Oral	1. Yes 2. No
b. Inhaled	1. Yes 2. No
c. Epi-pen medication	1. Yes 2. No
d. Insulin Injection	1. Yes 2. No

15.Do you have a health assistant at school?

a. Yes	b. No

16. Delegating nursing actions to unlicensed personnel is part of my role (For example schoolteacher giving inhaler).

a. Yes	b. No

17. What type of medication labels is acceptable in your region?

a. Pharmacy Label	b. Parent Label	c. Both

Exacerbation Management

18. In your school, who is the person most likely to take care of asthma-related medical emergency? You can circle more than one

a. Registered Nurse	b. Other Health Professional (Specify Position)	
c. School Principal	d. Other school personnel	e. Parent Liaison

19. In your school, how often do you see students with asthma exacerbation?

a. Daily	b. Once a week	c. Two to three times a week	d. Once a month
e. Once every other month	f. once every 6 months	g. Never	h. No asthmatic children at school

20. Where is an asthma episode usually documented? Circle all that apply (you can circle more than one)

a. Student health record	b. Letter sent to parent	c. Copy of parent letter placed in student's school record.
d. others (please specify)	e. No document kept	

Education/ Training

21. Are there education/training programmes available in your schools to prepare faculty/staff to care for and treat students with asthma? (If no go to question 24)

a. Yes	b. No

22. If there is a training available, who provides it? (circle more than one if relevant)

a. Registered Nurse	b. Other health professionals, specify	
c. School Principal	d. Schoolteacher	e. School secretary
f. Other school staff	g. Outside agency, please identify	

23. Are there age-appropriate asthma education materials for students in your school?

a. Yes	b. No

24. Do you use a peak flow meter when assessing children with asthma in your school?

a. Yes	b. No

25. Have you attended any asthma education programme?

a. Yes in the past 6 months	b. Yes in the past year
c. Yes, longer than a year ago	d. Never

26. Do you use any asthma guidelines in your school when you provide care for a student with asthma?

a. Yes	b. No
if yes please specify authors of asthma guidelines	

27. Are you an active member of any school nurse association?

a. Yes	b. No

28. If yes, please, list any school nurse association in which you are an active member of.

29. Please, list the essential issues you would like to see in an asthma education programme for school nurses?

Thank you for your participation

End of the Survey

Appendix 6.8 Asthma Knowledge Survey for School Nurses

The purpose of this survey is to measure school nurses' knowledge level in performing asthma management care for schoolchildren. Your answers will help to determine what education/ training school nurses require and what strengthen the application of evidence-based asthma care at school setting. There are no right or wrong answer. All of your answers will be kept confidential.

Please write the name of the school:

#	Please indicate whether the following statements are True or False.	True	False
1	Peak flow meters are used to determine if someone has asthma		✓
2	Uncontrolled asthma can impair lung growth in children.	✓	
3	The four classifications of asthma according to the most recent asthma guidelines are: mild intermittent, mild persistent, moderate persistent and severe persistent.	✓	
4	A child, whose age is from 5-11 years with asthma, who needs to use a rescue inhaler 2 times a week and oral steroids once this year is considered well controlled.		✓
5	A child with asthma with a peak flow reading of 85% is considered in the yellow zone and should initiate their asthma action plan.		✓
6	Children should use a spacer or valved holding chamber when taking their dry powder inhalers.		✓
7	Asthma is an emotional disease.		✓
8	Asthma, regardless of its severity, is a chronic inflammatory disorder of airways.	✓	
9	If asthma symptoms such as tightness or wheezing do not occur for several years, a child has outgrown his/her asthma.		✓
10	Airway inflammation is present in almost all children with asthma, even when asthma symptoms are well-controlled.	✓	
11	People with asthma can usually control their symptoms by taking medicine and avoiding things that make their asthma worse.	✓	
12	Children with asthma can be cured with medication.		✓
13	It is possible for your asthma to be worse without noticing a change in your breathing.	✓	
14	Untreated asthma can cause death.	✓	
15	An early sign of asthma may be a chronic cough, especially at night.	✓	
16	Children with asthma should not participate in activities in which they run a lot	✓	
17	Fish and birds are both good pets for a child with asthma.		✓

18	Keeping the bedroom windows open at night will help prevent asthma symptoms.		✓
19	A rescue inhaler (i.e., bronchodilator) is taken to reduce the inflammation in lungs.		✓
20	The purpose of steroid medication inhalers is to stop an asthma exacerbation when it occurs.		✓
21	Children with asthma do not need to take medicine if they feel normal.		✓
22	It may take 1-4 weeks to notice improvement in breathing when the child start using inhaled steroid medication.	✓	
23	When using a dry powder inhaler, the powder needs to be inhaled by taking a slow and deep breath.	✓	
24	After taking a quick acting inhaler, the child should hold their breath for 10 seconds after each puff and wait one minute between puffs	✓	

Appendix 6.9 Asthma Self-efficacy Survey for School Nurses

The purpose of this survey is to measure school nurses' self-efficacy level in performing asthma management care for schoolchildren. Your answers will help to determine what strengthen school nurses' self-efficacy level. There are no right or wrong answer. All of your answers will be kept confidential. Please tick True, Mostly True, Mostly False, or False where applicable.

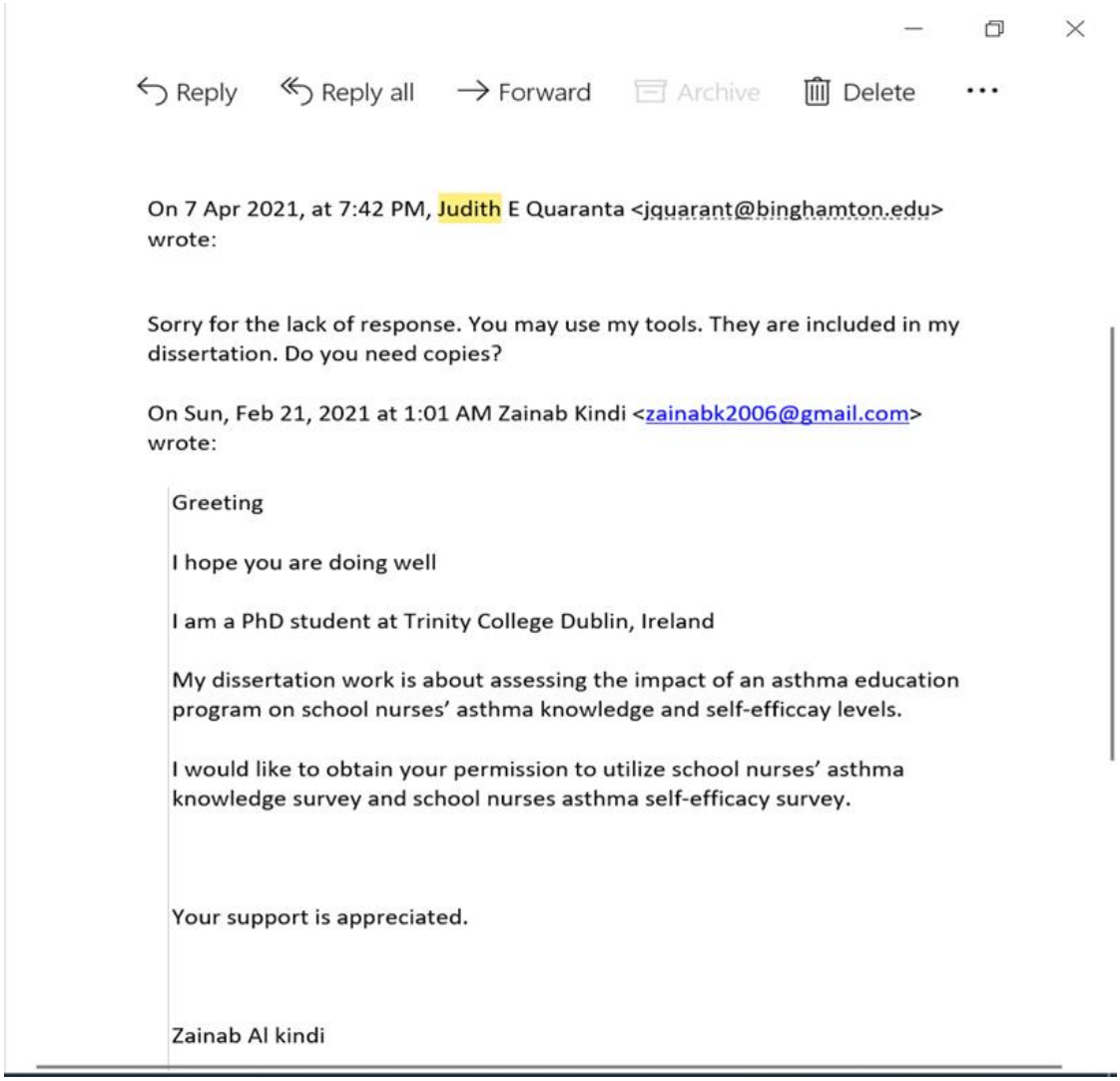
Please write the name of the school:

#	Statement	True	Mostly True	Mostly False	False
1	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the primary health care provider and discussing my concerns.				
2	When I have concerns or questions about a child's asthma management, I feel comfortable contacting the child's parents and discussing my concerns.				
3	I can correctly assess the needs of students with asthma.				
4	I can correctly demonstrate how to use a dry powder inhaler.				
5	I can correctly demonstrate how to use a peak flow meter.				
6	I have the ability to evaluate the effectiveness of the self-management efforts of the student with asthma.				

7	I can correctly choose which asthma medication to give depending upon which asthma symptoms the student is experiencing.				
8	I can influence students with asthma and their parents to reduce asthma triggers at home by teaching asthma environmental control.				
9	I can teach students with asthma to choose the correct self-management response based on the red, yellow, and green light system.				
10	I can determine when to administer asthma medication when the student with asthma is having symptoms.				
11	I can determine when to send the student with asthma to the emergency room.				
12	I can determine when to send the student with asthma back to the classroom.				
13	I can manage an asthma attack in school without needing to send the child home or to the emergency room.				
14	I can provide asthma instruction in a clear manner that the students can understand.				

15	I can determine whether the asthma medication is working for a student having an asthma exacerbation.				
16	l can determine the severity of an asthma attack based on the symptoms.				
17	I can help the student with asthma avoid asthma symptoms.				
18	I can take the necessary steps to avoid or to manage an asthma attack effectively.				
19	I have a lot of confidence in my ability to detect the early warning signs of asthma.				

Appendix 6.10 Permission to Use Asthma Knowledge and Asthma Self-Efficacy Questionnaires by Judith Quaranta



Reply Reply all Forward Archive Delete ...

On 7 Apr 2021, at 7:42 PM, Judith E Quaranta <jquarant@binghamton.edu> wrote:

Sorry for the lack of response. You may use my tools. They are included in my dissertation. Do you need copies?

On Sun, Feb 21, 2021 at 1:01 AM Zainab Kindi <zainabk2006@gmail.com> wrote:

> Greeting
>
> I hope you are doing well
>
> I am a PhD student at Trinity College Dublin, Ireland
>
> My dissertation work is about assessing the impact of an asthma education program on school nurses' asthma knowledge and self-efficcay levels.
>
> I would like to obtain your permission to utilize school nurses' asthma knowledge survey and school nurses asthma self-efficacy survey.
>
> Your support is appreciated.
>
> Zainab Al kindi

Appendix 6.11 Instructions and Rating Scales for Validation of Surveys

Dear Experts

This Documents contains 3 tools, Regional Needs Assessment Survey for School Nurses, School Nurse Asthma Knowledge Questionnaire, School Nurse Asthma Self-Efficacy Questionnaire. The project titled "Impact of School Nurse Asthma Education Programme on School Nurses' Asthma Knowledge and Self-Efficacy Level". We need your expert judgment on the degree of relevance and importance of each item. You can add comments beside each item. Kindly be as objective and constructive as possible by following the below scale

"1"= not relevant

"2"= Somewhat relevant

"3"= quite relevant

"4"= highly relevant and succinct

Appendix 6.12 Participant Information Leaflet Phase 2

Name of Study: Impact an Asthma Education Programme has on School Nurses' Asthma Knowledge and Confidence Level in managing school children with Asthma

Site	**Oman, Muscat Governate**
Principal Investigator(s) and Co-Investigator(s) (insert names, titles and contact details)	**Mrs. Zainab Al kindi** **Email ALKINDIZ@tcd.ie Phone#+96897177112** **Co-researcher: Dr Catherine Mc Cabe Email:camccabe@tcd.ie** **Co-researcher: Dr. Margret Mc Cann Email: mccannm1@tcd.ie**
Study Organiser/ Sponsor (if applicable)	**Ministry of Higher Education, Oman**
Data Controllers	**Trinity College Dublin (for research data)**
Data Protection Officer	**Data Protection Officer** **Secretary's Office** **Trinity College Dublin** **Dublin 2**

You are being invited to take part in a research study that is being done by Trinity College Dublin, Ireland by Zainab Al kindi at Ministry of Education, Oman.

Before you decide whether or not you wish to take part, please read this information sheet carefully. Ask Mrs. Zainab Al Kindi any questions. Don't feel rushed or under pressure to make a quick decision. You should understand the risks and benefits of taking part in this study so that you can make a decision that is right for you. You may wish to discuss it with your family or friends. This leaflet has five main parts: Part 1 – The Study

Part 2 – Data Protection

Part 3 – Costs, Funding and Approval

Part 4 – Future Research

Part 5 – Further Information

Part 1 – The Study

Why is this study being done?

- This study is planned to provide a baseline data on school nurses roles, functions, responsibilities, and educational needs in-relation to asthma management at schools. We are doing this study to provide evidence-based asthma education to school nurses to enable them to express their educational needs, communicate with community and other health care professionals, and to be able effectively manage asthma at school setting.

Why have I been invited to take part?

- You are invited to take part in this study because you are a school nurse working in a governmental school at Al Seeb or Bousher county, Muscat Governate.
- All school nurses working at Al Seeb and Bousher governmental schools in Muscat Governate are invited to participate.

Do I have to take part? Can I withdraw?

- You do not have to take part in this study. It is up to you to decide whether or not to take part. The participation in the study is entirely **voluntary**.
- If you wish to participate, you will be given this information sheet to keep, and you will be asked to sign a consent form.
- If you wish to participate, you are still free to withdraw without giving a reason for not taking part.
- You can withdraw from the study at any point of time, however, it will not be possible to remove your data from the research once it has been coded as we will not be able to identify your specific data. Yet, this does not affect your data protection rights. That means you will have the right to access your data, the right to modification, the right to erasure.

- If you wish not to participate, there is no adverse consequences. Your name will just be removed from participants' list. It won't affect your job evaluation, career development, and access to continuing education courses**.**
- If you wish to withdraw you can contact the researcher directly through phone number +96897177112 or via email: alkindiz@tcd.ie who will be able to organise this for you.

What happens if I change my mind?

- You can change your mind at any time by contacting Mrs Zainab Al kindi at +96897177112.

- The participation in this study is voluntary. You can withdraw from the study at any point of time even if the study has started. You won't have to give a reason for not taking part or for opting out.
- Withdrawal from the study will not in any way affect you job evaluation, career development, and access to continuing education courses.
- If you wish, you can ask for your data stored to be destroyed. If you request this, we will destroy all data that are still in our possession.
- We will no longer use or share your data for research from this point onwards. However, it will not be possible to destroy data already analysed before this time

How will the study be carried out?

- I , the researcher, will contact the General Director at Ministry of Education, Oman to identify and provide a list of governmental schools having school nurses at Muscat Governate.

- The list of eligible participants will be given to a gatekeeper (who was nominated by the General Director).
- The gatekeeper will approach the school principle to obtain permission to access the school. The gatekeeper will provide you with the invitation letter and participant information leaflet including brief information about the study and the researcher contact details to help you understand the research aim and to make a decision about participating.

- If you agree to participate, the gatekeepers will instruct you how to contact the researcher within seven days from getting this patient information leaflet.
- You and I, the researcher, sooner you notify me with your desire to participate, will sign the consent form.
- I, the researcher will administer two surveys (NAKQ, Confidence Survey) to you and once you finish you can put it in the provided envelope, sealed it and place it at the principle office. I, the researcher, will then arrange with you a convenient time for an asthma training session of 4-hour duration.
- Immediately after the training session, you will be asked to complete the two surveys you filled before the training session. Three months after the asthma training session, you will need to complete the same tow survey (Newcastle Asthma Knowledge Survey, Confidence Survey) that will be sent to your school.

What will happen to me if I decide to take part?

- If you agree to participate, you will be invited to fill two surveys (NAKQ, Confidence Survey) that explore school nurses' asthma knowledge and confidence level in relation to asthma management at school setting.
- You will then be invited to attend an asthma education session of 4-hour duration. The session will take place at a setting convenient to you and you will be notified about the session timing and location 3 weeks prior to the intervention.
- You will complete the NAKQ and the confidence survey immediately after the session and you will again complete the NAKQ and Confidence Survey three months after the session.

What will happen to my Samples and Data?

- No biological samples will be obtained for the study.
- All the study data are about school nurses' knowledge and confidence level in relation to asthma management at school setting.
- All data including the consent forms will be stored securely in a locked drawer in a locked office at the researcher's home and will be uploaded electronically to the university research data storage for additional security purposes.
- Your personal data (demographic data) will be assigned a code, and your data will also be identified only by this number. Code keys will be shared only with the researcher supervisor.
- Your personal data will be kept for 7 years and then they will be destroyed according

to the policies and regulations.

Are there any benefits to taking part in this research?

Taking part in this study will promote your asthma knowledge and management skills. The research may help us plan school nurses' continuing educational sessions. In addition, it may help us to establish a baseline data on the current school nurses' asthma educational needs in Oman, which will result in implementing asthma training sessions that promote school nurses' knowledge and practice. By participating in this study, you are facilitating advance school nursing care in the country.

Are there any risks to me or others if I take part?

- There is no risk that a connection to your identity could be made. Attention will be taken to ensure the confidentiality of all data.
- All data will be pseudonymised, and no actual identification will be used. Your participation in the study will be kept confidential to the study team (Study supervisors and me).
- The researcher is the only one who will have access to the records. Any personal information such as your name will be removed in the final transcript

What happens if something goes wrong when I'm taking part in the study? *(May not apply)*

It is unlikely that your participation in this study will cause harm.

Will I be told the outcome of the study? Will I be told the results of any tests or investigations performed as part of this study that relate to me?

- The results of the study will be published in a scientific journal and disclosed at a scientific conference/symposium. However, no information which reveals your identity.
- If you would like, you can receive a copy of the study results.

Part 2 – Data Protection

The following information should also be included as standard in Participant Information Leaflets, in order to ensure compliance with the 2018 Health Research Regulations.

What information about me (personal data) will be used as part of this study? Will my medical records be accessed?

- The gatekeeper (nominated by the General Director at Ministry of Education) will have access to the address of the school you are working in.
- Demographic data such as sex, age, educational level, years of nursing experience will be gained.
- Your name, mobile number and mobile number will be collected from you during consent time. Those data will be accessed by the researcher only.

What will happen to my personal data?

We are collecting and storing this personal information following the General Data Protection Regulation (GDPR) and Data Protection Act 2018 and Health Research Regulations 2018, which legislate to protect your personal information.

To protect your confidentiality and keep your data safe, the following steps will be taken;

- Personal information will be kept at a locked cabinet in private office at researcher's home.
- Your coded personal data will only be shared with my supervisor.
- Your names will be removed and pseudonymised when the results of this study will be published in a scientific journal and at a conference/symposium.
- Your coded personal data will be kept for 7 years and then they will be destroyed according to the policies and regulations.

Who will access and use my personal data as part of this study?

The researcher Mrs. Zainab Al Kindi will have access to the data. The supervisors Dr Catherine Mc Cabe and Dr. Margret Mc Cann will have access the pseudonymised data.

Will my personal data be kept confidential? How will my data be kept safe?

Your privacy is important to us. We take many steps to make sure that we protect your confidentiality and keep your data safe. Here are some examples of how we do this:

To protect your confidentiality and keep your data safe, the researcher had trained in data protection law, and the following steps will be taken;

- Documented information will be kept secured.
- Your information will not be used in future studies without obtaining your consent.
- Your name will be removed and pseudonymised when the results of this study will be published in a scientific journal and at a conference/symposium.
- The transferred of pseudonymised data to my supervisors will be through encrypted emails.

What is the lawful basis to use my personal data?

By law,[4] the researcher can use your personal information for scientific research [5] (in the public interest[6]). I will ask you to sign a consent form to use your data as a requirement of the Irish Health Research Regulation.

What are my rights?

You are entitled to:

- The right to access to your data and receive a copy of it.
- The right to restrict or object to the processing of your data if you decide to withdraw unless non-identifiable data are already analysed.
- The right to object to any further processing of the information we hold about you (except where it is de-identified).
- The right to have inaccurate information about you corrected or deleted.
- The right to receive your data in a portable format and to have it transferred to another data controller.
- The right to request deletion of your data.

By law, you can exercise the following rights about your personal data unless the request would make it impossible or very difficult to conduct the research. You can exercise these rights by contacting the study researcher at alkindiz@tcd.ie/mobile No: +96897177112 or the Trinity

[4] The European General Data Protection Regulation (GDPR)
[5] *Article 9(2) (j))*
[6] *(Article 6(1)(e)*

College Data Protection Officer, Secretary's Office, Trinity College Dublin, Dublin 2, Ireland. Email: dataprotection@tcd.ie. Website: www.tcd.ie/privacy

Part 3 – Costs, Funding and Approval

Has this study been approved by a research ethics committee?

- Yes, this study has been approved by the Faculty of Health Science Research Ethics Committee, Trinity College Dublin. Approval was granted on [INSERT DATE].
- Furthermore, it is approved by the Research and ethics committee of Ministry of Education (DATE) and the Medical Research Ethical Committee at Ministry of Health on (DATE).
- The researcher will provide a progress report yearly (within 12 months period) for the Faculty Research Ethics Group at Trinity College Dublin. **Also, in case of a serious issue that is related to your protection, the researcher will report immediately to the Faculty Research Ethics Group at Trinity College Dublin**

Who is organising and funding this study? Will the results be used for commercial purposes?

Mrs. Zainab Al kindi is conducting this research as part of her PhD study at the School of Nursing and Midwifery, Trinity College Dublin. The Ministry of Higher Education in Oman funds this study. There is no relationship between the Ministry of Higher Education and Ministry of Education and Ministry of Health. There is no conflict of interest between the funder and the study setting. The results of this study will not be disclosed for the Ministry of Higher Education and will not be utilised for commercial purposes.

Is there any payment for taking part? Will it cost me anything if I agree to take part?

Part 4 – Future Research

No, we are not paying participants to take part in the study. However, the training session you will attend will be arranged at your working day. You do not need an additional day to attend the session.

Will my personal data and/or biological material be used in future studies? (May not apply)

Your personal data will be used for this study only. If your data will be processed for future studies, this will not happen without obtaining your consent.

Part 5 – Further Information

Who should I contact for information or complaints?

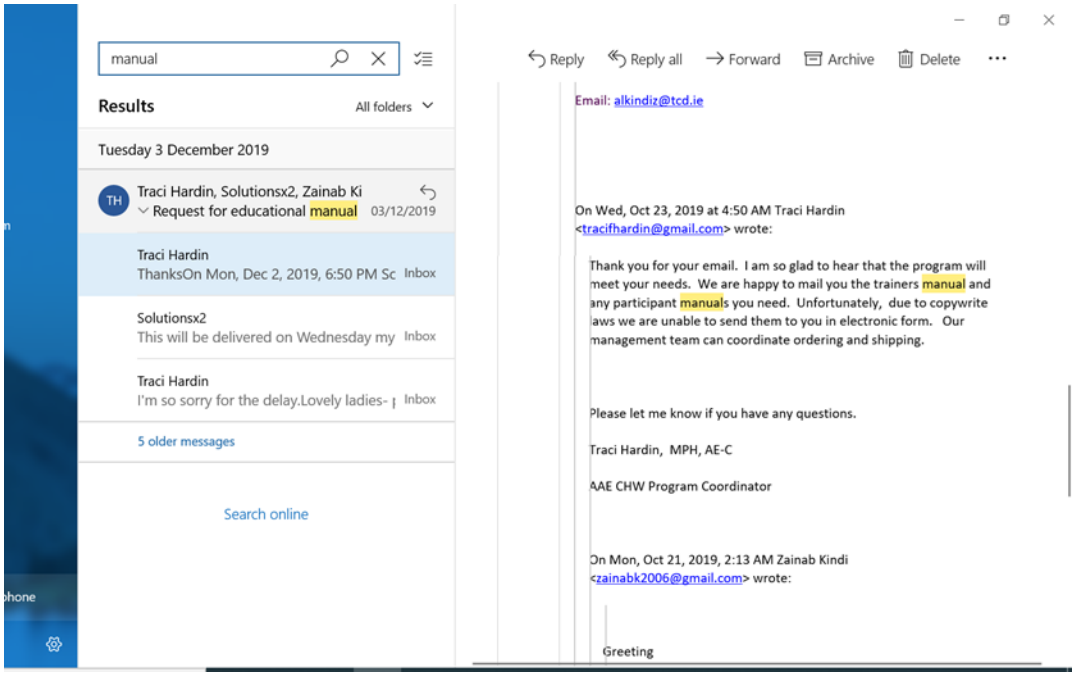
If you have any concerns or questions, you can contact:

- Principal Investigator: Mrs Zainab Al kindi, mobile No: +96897177112, e-mail: alkindiz@tcd.ie.
- Data Protection Officer, Trinity College Dublin: Data Protection Officer, Secretary's Office, Trinity College Dublin, Dublin 2, Ireland. Email: dataprotection@tcd.ie. Website: www.tcd.ie/privacy.
- Under GDPR, if you are not satisfied with how your data is being processed, you have the right to complain with the Office of the Data Protection Commission, 21 Fitzwilliam Square South, Dublin 2, Ireland. Website: www.dataprotection.ie.

Will I be contacted again?

If you would like to take part in this study, you will be asked to sign the Consent Form on the next page. You will be given a copy of this information leaflet and the signed Consent Form to keep.

Appendix 6.13 Permission to Use the Educational Content of Association of Asthma Educators



Appendix 8.1 List of Medication Available in schools

List of Medication Available in the Clinic
Paracetamol Tablets 500 mg
Paracetamol Syrup
Hyoscine- N- butyl bromide (Buscopan) 10-20 mg tab
Pyrethrine Antilice Shampoo
Chlorhexidine Solution Sachets (Antimicrobial soup)
Antimicrobial Cream
Epinephrine pen
Nebulizer Puff

Appendix 8.2 School health supplies list in school health clinic

Pre	Code	Item Description	Max Qty/ school	Category	Indent frequency	School nurse Only
070M/	1266	Face mask-disposable	1 box	All	Annual	✓
070M/	29082	Unsterile disposable gloves-small	1 box (1 size only)	All	Annual	✓
070M/	29098	Unsterile disposable gloves-medium		All	Annual	✓
070M/	29103	Unsterile disposable gloves-large		All	Annual	✓
070M/	96184	Digital thermometer	1	All	Annual	
060D/	718	Monojet blood lancets (100/pkt)	50	All	Annual	✓
060D/	9710	Sharp container 7Ltr	1	All	Annual	✓
060R/	60227	Glucose in blood test (50/kit)	50	All	Annual	✓
02/	3263	Paracetamol 125mg/5ml syp	10	Class 1-6	bimonthly	
03/	7535	Paracetamol 500mg tab	50	Class 7-12	bimonthly	
090S/	420	Chlorohexidine+ Cetrimide cream	2	All	bimonthly	✓
090S/	2579	Chlorhexidine+ Cetrimide soln sachet	10	All	Bimonthly	
05/	660	Crepe bandage 5cm	12	All	Bimonthly	
05/	681	Crepe bandage 10 cm	12	All	Bimonthly	
05/	1376	Paraffin impregnated gauze 10x10 (10/pkt)	1 pkt	All	Bimonthly	
05/	1491	Gauze sachets 10cm	10	All	Bimonthly	
05/	2013	Microspore adhesive tape 5cm	1	All	Bimonthly	
05/	2563	Dressing pack-disposable	10	All	Bimonthly	✓
050M/	1670	Chlorohexidine 4% alcoholic liquid rub	1	All	Bimonthly	✓
050M/	1685	Chlorohexidine 4% liquid	1	All	Bimonthly	✓
070M/	3090	Incontinence pad 75 x 75 cm	25	All	Bimonthly	✓
070M/	4602	Disposable Digital thermometer sheath	25	All	Bimonthly	
05/	860	Cotton ball		All	EPI	
05/	2029	Micro-pore adhesive tape 2.5cm		All	EPI	
070M/	173	Auto disable syringe 0.5ml-23G	or 2ml syringe & 25G needle	All	EPI	
070G/	3530	Metzenbaum scissors 7 inch-straight	1	All	Once only	✓
060E/	4911	Glucometer	1	All	Once only	✓