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The effect of multiple chronic conditions on self-rated health, disability and quality of life among the older populations of Northern Ireland and the Republic of Ireland: a comparison of two nationally representative cross-sectional surveys

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ABSTRACT

Objectives: Multimorbidity is common in the older population, but the impact of combinations of chronic conditions on disability and quality of life (QoL) is not well known. This analysis explores the effect of specific combinations of chronic diseases on disability, QoL and self-rated health (SRH).

Design: We used data from two population representative cross-sectional studies, the Northern Ireland Health and Social Wellbeing Survey (NIHSWS) 2005 and the Survey of Lifestyle, Attitudes and Nutrition (SLAN) 2007 (conducted in the Republic of Ireland).

Setting: Randomly selected community-living participants were interviewed at home.

Participants: A total of 6159 participants aged 50 years and older were included in the analysis.

Outcome measures: Chronic conditions were classified as cardiovascular disease, chronic pain, diabetes or respiratory disease. Interaction terms estimated by logistic regression were used to examine the effects of multiple chronic conditions on disability, SRH and QoL.

Results: Each chronic condition group was correlated with each of the others after adjusting for sociodemographic factors. Those from Northern Ireland were more likely to report a limitation in daily activities (45%) compared to those from the Republic of Ireland (21%). Each condition had an independent effect on disability, SRH and QoL, and those with multiple chronic conditions reported the worst outcomes. However, there were no statistically significant positive interactions between chronic condition groups with respect to any outcome.

Conclusions: Chronic conditions affect individuals largely independent of each other with respect to their effect on disability, SRH and QoL. However, a significant proportion of the population aged 50 years and over across the island of Ireland lives with multimorbidity, and this group is at the highest risk of disability, poor SRH and poor QoL.

ARTICLE SUMMARY

Article focus

- The reported rates of disability are considerably higher among the older population of Northern Ireland (NI) than in the Republic of Ireland (RoI), but the reasons for this are not known.
- Multimorbidity is common in older people, and disability, poor self-rated health and poor quality of life are more common among those with multiple chronic conditions.
- We aimed to explore the effects of particular combinations of chronic conditions on disability, quality of life and self-rated health across Ireland and to test whether higher rates of chronic disease or multimorbidity explained the difference in disability rates across the island of Ireland.

Key messages

- There are no substantial interactions between cardiovascular disease, lung disease, diabetes and chronic pain with respect to their effects on disability, poor self-rated health and poor quality of life. This means that the sum of the main effects of each condition is sufficient to explain the poor health outcomes associated with multimorbidity and that no synergistic 'multimorbidity' effect is needed.
- Middle-aged and older people in NI are far more likely to report limitations in daily activities (OR 2.8, 95% CI 2.5 to 3.2) than those in RoI even after adjusting for the moderately higher rates of chronic disease in NI compared to RoI.

INTRODUCTION

Trends in the health of ageing populations are complex. While there is evidence of a compression of morbidity and serious disability in developed countries including Ireland,[1-5] the

ARTICLE SUMMARY

Strengths and limitations of this study
- This study uses two large population representative datasets conducted at a similar time and using similar methodology to ascertain chronic disease and other outcomes and covariates, and so the results are applicable to the national population and are comparable between regions.
- However, some of the questions regarding chronic diseases and outcomes are not exactly identical across the studies, and the limited number of diseases ascertained in both studies meant that an exhaustive account of chronic disease multimorbidity was not possible. Disability, self-rated health and quality of life were each ascertained by a single question.

proportion of the older population suffering from chronic conditions is expected to increase substantially in the years ahead.[6–8] Multimorbidity, defined as two or more chronic conditions, is common in older people[9][10] and is associated with increased healthcare utilisation,[11][12] greater levels of disability, dependency and a diminished quality of life (QoL).[11][13–16] Although they have larger proportions of younger people than in the rest of the British Isles, both Northern Ireland (NI) and the Republic of Ireland (RoI) are experiencing the same demographic shift towards an older population, and so the expected increase in multimorbidity and the associated disability burden presents a significant challenge for health professionals and policymakers across the island.[5] Previous research has suggested that chronic conditions, poor self-rated health (SRH) and functional impairment are more common in NI than in the RoI and in those from lower socioeconomic groups in both regions.[8][17][18]

The effect of multiple chronic diseases on the functional ability and well-being of older people is not well understood. While multimorbidity has been shown to lead to disability,[11][19] poor SRH[20] and diminished QoL,[21–23] little is known about how specific combinations of conditions lead to adverse outcomes. Previous works have suggested synergistic effects between some specific pairs of physical and mental chronic conditions[24][25] but not others with respect to the risk of functional ability, but how specific pairs of conditions affect QoL or SRH is largely unexplored.

Here, we estimate the prevalence of four groups of chronic conditions and their combined effects on SRH, disability and QoL using data from two studies representative of the older population across the island of Ireland. We consider both 'multimorbidity', defined by the number of groups of chronic conditions present, and the prevalence and effects of specific combinations of conditions. Our aim is to better understand the interactions between chronic conditions with respect to adverse outcomes in the older population and to test whether differences in the chronic disease profile can account for the previously reported differences in the rate of disability between NI and RoI.

METHODS

Study sample

This investigation was based on harmonisation of data from two population-representative studies of health: the Survey of Lifestyle, Attitudes and Nutrition in Ireland (SLAN) 2007, which conducted face-to-face interviews with 10 364 adults aged 18 years and over in RoI and the 2005 Northern Ireland Health and Social Wellbeing Survey (NIHSWS), which gathered data from 4245 individuals aged 16 years and above in NI. These data sources have previously been combined to compare health and lifestyle factors across the island of Ireland[17] and the design of both surveys are described in full elsewhere.[17][26] The present analysis included all participants of both studies aged 50 years and over, giving a total sample size of 6159 (1904 from NI and 4255 from RoI).

Measures of chronic conditions and health outcomes

The harmonised dataset included indicators for the presence of seven key chronic conditions: heart attack, angina, stroke, asthma, chronic obstructive pulmonary disease (COPD), diabetes, musculoskeletal pain (including rheumatism, arthritis and back pain) and cancer. Online supplementary appendix 1 lists all questions used to ascertain the presence or absence of each condition. For all conditions except chronic pain, 'presence' was defined by a self-report of a doctor's diagnosis and the condition being present within the previous year. These were recoded into four organ system groups: cardiovascular disease (CVD, defined as the presence of a heart attack, angina or stroke), respiratory disease (COPD or asthma), diabetes and musculoskeletal pain.

Disability is measured by a self-report of limited activity due to an illness or health problem. SLAN participants were asked "Is your daily activity limited by a long-term illness, health problem or disability?" NIHSWS participants were asked "Do you have any long-standing illness, disability or infirmity? By long-standing I mean anything that has troubled you over a period of time and, if yes, does this illness or disability limit your activities in any way?"

QoL was determined by the question "How would you rate your quality of life." Responses of 'poor' or 'very poor' were considered 'poor' QoL, whereas all other responses (very good, good, neither good nor poor) were considered 'good'. SRH was measured by a single question "In general would you say your health is" in SLAN and "How is your health in general, would you say it was..." in NIHSWS. A response of excellent, very good or good was considered 'good' SRH, whereas a response of fair, poor or very poor was considered 'poor' SRH.

Covariates

Age was considered in three groups: 50–64, 65–74 and 75+ years. Marital status was dichotomised as living alone (single, widowed, separated or divorced) or living with a partner (married or cohabiting). Socioeconomic status (SES) was measured by current occupation (previous if

retired). The Central Statistical Office (CSO) 1996 classification of occupations[27] was used to characterise individuals as high (professional/managerial/technical), mid (non-manual/skilled manual) or low (semiskilled/ unskilled). Respondents who were unemployed or did not provide enough information to be classified were included as a separate group in multivariate analyses. Owing to the slight variation in questions and because differences between regions are of direct interest, the source of the data, that is, SLAN versus NIHSWS, was also included as a covariate in all multivariate analyses.

Statistical analysis

The association between conditions was measured using logistic regression, both univariately and after adjusting for all potential confounders. The number in the sample with each number and with each combination of conditions was found and prevalence was estimated by applying the weights supplied with each dataset to the sample proportions. The prevalence of disability, poor SRH and poor QoL was found within each group.

Logistic regression was used to examine how the cooccurrence of diseases affected each of the outcomes. First, the effect of the number of chronic conditions was estimated after adjusting for all potential confounders. Finally, the effect of each condition and the additional effect of each pair of conditions were examined by estimating a model, including the main effect of each condition and the interactions between each pair as well as all covariates. All analyses were conducted using Stata V.12.0.

In SLAN, 139 participants (3%) had missing data for one or more chronic conditions. In our primary analysis, such conditions were assumed to be absent, in line with the NIHSWS protocol. We conducted a sensitivity analysis excluding these cases with no substantial impact on results. To assess the effect of limiting our analysis to dichotomous outcomes, secondary analyses were conducted using ordinal logistic regression to model the full range of responses to the QoL and SRH questions. Again, there was no substantial impact on results and so, for ease of interpretation, the primary analysis is presented.

RESULTS

Table 1 shows the characteristics of our sample. The demographic profiles of the two samples are similar, but all the adverse outcomes that we considered were more commonly reported in NI than in RoI.

Table 2 shows ORs corresponding to the pairwise associations between each group of conditions, both univariately and after adjusting for age, sex, marital status, socioeconomic group and region. In multivariate

Table 1 Demographic profile of SLAN 2007 and NIHSWS 2005 samples and the numbers with disability, poor self-rated health and poor quality of life

	SLAN 2007		NIHSWS 2005	
	N	Per cent	N	Per cent
Sex				
Male	1838	43	818	43
Female	2417	57	1086	57
Age				
50–64	2286	54	952	50
65–74	1150	27	549	29
75+	819	19	403	21
Marital status				
Married	2427	57	1180	62
Single	1815	43	724	38
SES				
High	1216	29	374	20
Mid	1577	37	788	41
Low	868	20	537	28
Missing	594	14	205	11
Chronic conditions				
Cardiovascular disease	297	6	223	11
Lung disease	376	9	151	8
Diabetes	256	6	154	8
Chronic pain	1540	35	1050	55
Outcomes				
Limited daily activity	881	21	856	45
Poor self-rated health	1060	25	784	41
Poor quality of life	636	15	384	20

NIHSWS, Northern Ireland Health and Social Wellbeing Survey; SES, socioeconomic status; SLAN, Survey of Lifestyle, Attitudes and Nutrition.

Table 2 Pairwise associations between chronic conditions, measured by ORs reflecting the increased prevalence of one condition in the presence of the other

	Cardiovascular disease	Lung disease	Diabetes	Chronic pain
Cardiovascular disease	–	2.46 (1.92 to 3.15)	3.01 (2.32 to 3.91)	2.18 (1.81 to 2.61)
Lung disease	2.41 (1.86 to 3.11)	–	2.17 (1.64 to 2.88)	2.15 (1.79 to 2.58)
Diabetes	2.43 (1.85 to 3.19)	2.09 (1.57 to 2.78)	–	1.43 (1.17 to 1.75)
Chronic pain	1.95 (1.61 to .36)	2.17 (1.80 to 2.62)	1.33 (1.08 to 1.64)	–

Univariate associations are shown above the diagonal, and ORs estimated by logistic regression adjusted for age, sex, SES, marital status and the source of the data are shown below the diagonal.
SES, socioeconomic status.

analysis, every condition is positively correlated with each of the others. The strongest association is observed between diabetes and CVD, the weakest between diabetes and pain.

Table 3 shows the distribution of combinations of conditions and the proportions with disability, poor SRH and poor QoL in each group. Just over half of the older population of Ireland did not report any of the conditions we measured, and these individuals rarely reported disability (9.2%), poor health (11.9%) or poor QoL (8.9%). Around 30% reported only musculoskeletal pain with a significant effect on the prevalence of each outcome. Multimorbidity was reported by 733 individuals representing 11.3% of the population aged over 50 years in Ireland, with each of the combinations of two or more conditions being reported in 3% or fewer of the sample. Only 17 participants reported chronic conditions from all four groups, representing 0.3% of the population. CVD with chronic pain appears to be a particularly problematic combination of the conditions. Each of the subgroups including both these conditions has particularly high rates of disability, poor SRH and poor QoL, although all of those with multimorbidity do appear to have a high risk of disability, poor SRH and poor QoL.

The effect of increasing levels of multimorbidity on each of the three health outcomes (disability, poor health and poor QoL) is shown in table 4. After adjusting for age, sex, marital status, socioeconomic position and the source of the data, there is a clear increase in the risk of each outcome for each of the first three chronic conditions. Moreover, the increase in odds of all outcomes appears roughly similar (on a multiplicative scale) for each of the first three conditions added. Those with three or more chronic conditions are at extremely high risk of disability (80–90%), and unsurprisingly, the majority of these rate their health as poor, while just under half rate their QoL as poor. The number of individuals with four chronic conditions is too small for meaningful analysis, but their profile of outcomes seems similar to that of the group with three conditions.

Table 3 Pattern of chronic disease cooccurrence in the Irish population, and the proportion among those with each combination who suffer from limitations in daily activities, poor self-rated health and poor quality of life

Cardiovascular disease	Lung disease	Diabetes	Musculoskeletal pain	Number in sample	Population (%)	LDA (%)	Poor SRH (%)	Poor QoL (%)
–	–	–	–	2947	51.5	9.2	11.9	8.9
–	–	–	1	1849	29.1	36.3	34.3	17.7
–	1	–	1	212	3.4	60.8	64.8	31.4
1	–	–	1	201	3.1	78.8	73.5	42.9
–	1	–	–	175	3.1	36.2	39.1	22.6
1	–	–	–	163	2.4	54.9	57.8	31.9
–	–	1	–	151	2.6	24.2	36.9	12.7
–	–	1	1	126	1.9	52.7	67.1	26.9
1	1	–	1	53	0.7	89.2	91.8	45.9
1	–	1	1	35	0.5	91.5	80.2	50.8
1	–	1	–	26	0.4	65.9	74.1	26.6
–	1	1	1	25	0.4	76.3	91.2	38.4
–	1	1	–	19	0.3	63.4	69.8	33.9
1	1	1	1	17	0.3	81.7	89.5	47.2
1	1	–	–	15	0.2	52.5	43.9	20.2
1	1	1	–	4	0.1	62.4	62.4	50.6

Each row corresponds to a particular combination of chronic diseases, and these are sorted by their frequency in the combined sample.
Prevalences are weighted to the population aged 50 years and over of the island of Ireland.
LDA, limitation in daily activities; QoL, quality of life; SRH, self-rated health.

Table 4 Number in the sample with 0, 1, 2, 3 or 4 chronic conditions and prevalence in the population, and the proportion of the population in each group with limitation in daily activities, self-rated health and poor quality of life

Number of conditions	N	Prevalence (%)	Limitation in daily activities			Self-rated health			Poor quality of life		
			Per cent	OR	95% CI	Per cent	OR	95% CI	Per cent	OR	95% CI
0	2947	51.5	9.2	Ref		11.9	Ref		8.9	Ref	
1	2338	37.2	36.6	5.08***	4.21 to 6.12	36.4	3.83***	3.23 to 4.53	18.7	2.17***	1.77 to 2.67
2	599	9.3	65	15.53***	11.81 to 20.42	68.1	13.76***	10.62 to 17.84	33.9	4.59***	3.50 to 6.01
3	117	1.8	85.6	47.46***	24.44 to 92.16	86.8	38.26***	20.02 to 73.13	45.8	7.01***	4.36 to 11.27
4	17	0.3	81.7	31.48***	7.43 to 133.4	89.5	45.21***	10.79 to 189.4	47.2	6.55***	1.64 to 26.17

***p Value <0.001.
ORs for each outcome with respect to the group with 0 chronic conditions are adjusted for age, sex, marital status, source of the data and SES.
SES, socioeconomic status.

Table 5 shows the independent effects of each disease and each pair of diseases on disability, SRH and QoL after adjusting for age, sex, SES, marital status and region. The main effects indicate the effect of each disease in a person suffering none of the other conditions. The contribution of the second comorbid condition can be found by multiplying the main effect of that condition by the interaction between the first and the second. An interaction less than one therefore indicates that the effect of the two diseases is less than the multiplicative effect of each one individually, while an interaction of more than one indicates a synergistic effect. In brief, what table 5 shows is that while each of the conditions had a significant effect on each of the outcomes, there were no significant positive interaction effects between pairs of conditions.

With respect to disability, all the estimates of interactions are less than one, with the interactions between CVD and diabetes, CVD and chronic pain and lung disease and chronic pain all statistically significant and

Table 5 Logistic regression showing the effects of combinations of chronic diseases on disability (defined by a self-report of limitations in daily activities), poor self-rated health and poor quality of life

	Limitation in daily activities		Poor self-rated health		Poor quality of life	
	OR	95% CI	OR	95% CI	OR	95% CI
Main effects						
CVD	8.95***	6.43 to 12.45	7.41***	5.40 to 10.17	3.32***	2.36 to 4.68
Respiratory disease	5.40***	3.89 to 7.49	4.58***	3.35 to 6.26	2.32***	1.62 to 3.33
Diabetes	3.85***	2.72 to 5.46	4.09***	2.95 to 5.68	1.87**	1.27 to 2.77
Musculoskeletal pain	4.91***	4.20 to 5.74	3.16***	2.73 to 3.66	2.06***	1.74 to 2.45
Two-way interactions						
CVD×respiratory disease	0.72	0.36 to 1.45	0.49*	0.25 to 0.97	0.62	0.36 to 1.07
CVD×diabetes	0.48*	0.25 to 0.93	0.34***	0.18 to 0.65	0.6	0.34 to 1.06
CVD×pain	0.51**	0.32 to 0.80	0.69	0.45 to 1.06	0.96	0.63 to 1.45
Respiratory disease×diabetes	0.7	0.35 to 1.37	0.86	0.41 to 1.80	1.13	0.61 to 2.09
Respiratory disease×pain	0.54**	0.36 to 0.83	0.87	0.58 to 1.32	0.86	0.55 to 1.33
Diabetes×pain	0.64	0.40 to 1.03	0.95	0.60 to 1.51	0.86	0.53 to 1.40
Covariates						
Male	Ref	–	Ref	–	Ref	–
Female	0.81**	0.71 to 0.93	0.84*	0.74 to 0.96	0.87	0.75 to 1.01
Age 50–64 years	Ref	–	Ref	–	Ref	–
Age 65–74 years	1.14	0.97 to 1.33	1.19*	1.03 to 1.38	1.01	0.86 to 1.20
Age 75+ years	1.52***	1.27 to 1.81	1.39***	1.18 to 1.64	0.95	0.79 to 1.16
Republic of Ireland	Ref	–	Ref	–	Ref	–
Northern Ireland	2.81***	2.45 to 3.22	1.84***	1.61 to 2.10	1.22*	1.05 to 1.42
High SES	Ref	–	Ref	–	Ref	–
Mid SES	1.13	0.95 to 1.35	1.33**	1.12 to 1.58	1.33**	1.09 to 1.62
Low SES	1.21	1.00 to 1.47	2.02***	1.68 to 2.43	1.63***	1.32 to 2.02
Missing SES	1.48***	1.17 to 1.86	1.73***	1.38 to 2.16	1.61***	1.25 to 2.08
Married	Ref	–	Ref	–	Ref	–
Single or widowed	1.26**	1.09 to 1.45	1.32***	1.16 to 1.51	1.60***	1.38 to 1.86

*p Value <0.05; **p value <0.01; ***p value <0.001.
CVD, cardiovascular disease; SES, socioeconomic status.

around 0.5. In other words, in each of these cases, the effect of the second disease on the chance of reporting a limitation in daily activities (as measured by OR) in the presence of the first disease is about half of what the effect would be in the absence of the first disease.

A similar pattern is seen with respect to SRH. Each condition alone has a statistically significant positive effect on the odds of reporting poor SRH, but there are no statistically significant positive interactions. The interactions between CVD and lung disease and between CVD and diabetes are statistically significant and less than 0.5 (table 5).

The main effects of chronic conditions on QoL are lower than on disability or SRH, although each is statistically significant. No interactions were statistically significant, and estimates of interaction effects tended to be around 1 or less than 1.

In an additional model including all possible third and fourth order interactions, the higher order interactions were not statisticially significant and other effects were not changed, and so the model including only second order interactions is shown.

The much higher prevalence of disability seen in NI compared to RoI is reflected in the multivariate regression (OR 2.8, 95% CI 2.5 to 3.2), with a corresponding increase in the prevalence of poor SRH (OR 1.8, 95% CI 1.6 to 2.1) and a smaller but still statistically significantly higher prevalence of reported low QoL in NI (OR 1.2, 95% CI 1.1 to 1.4). Those in lower socioeconomic groups reported poorer SRH and QoL, but the effect of SES on disability after adjusting for all other factors was not statistically significant in the multivariate model.

DISCUSSION
Summary of findings
We have explored the relationships between chronic conditions in the older population of Ireland and how different combinations of chronic conditions interact to determine a range of health outcomes, including disability, SRH and QoL.

Each group of chronic conditions was positively associated with each of the others after adjusting for sociodemographic variables, reflecting the probable common risk factors and clustering of chronic conditions in susceptible individuals. Approximately 50% of the population aged 50 years and over reported no morbidity from the four groups of chronic conditions included in the analysis. Thirty per cent reported only musculoskeletal pain. With respect to their effects on disability, SRH and QoL, the majority of two-way interactions between condition groups were not statistically significant, and estimates of effects were small in magnitude, suggesting that most conditions affect the health-related outcomes we examined independently of each other. Interactions between CVD and other disease groups with respect to disability and SRH were less than one, suggesting that

CVD in the presence of any of the other chronic conditions has a smaller effect on these outcomes than CVD alone. Nevertheless, those with a chronic condition from more than one group are at very high risk of disability, poor SRH and poor QoL.

Patterns of multimorbidity
The different multimorbidity indices used previously make comparison of the prevalence of multimorbidity across populations difficult.[10] [28] The reported prevalence of multimorbidity in the older population is typically between 50% and 90%, but this is determined primarily by the range of conditions and the population being studied.[11] In our middle-aged and older population, 11% reported a chronic condition from more than one of the four groups we investigated, although the proportion with more than one chronic disease of any kind is likely to be much higher.

The pattern of chronic condition cooccurrence that we describe is similar to that found among the population aged 65 years and over in the USA using data from the National Health and Nutrition Examination Survey (NHANES),[29] where arthritis was by far the most prevalent condition leading to a high prevalence of multimorbidity including arthritis. A high prevalence of multimorbidity including a rheumatic disease (17%) was also reported in a sample of 2998 representative of the Spanish population aged 20 years and over,[30] and 'painful condition' was the most commonly recorded comorbidity among the primary care population of Scotland.[9]

Synergistic effects of disease combinations
Each chronic condition had a statistically significant independent effect on disability, poor SRH and poor QoL. Where significant interactions between diseases existed, they were negative, suggesting that the effect of multiple chronic diseases is less than or equal to the effects of each combined. That the effects of comorbid conditions appear to be less than the product of their individual effects (table 5) can seem at odds with the finding that the worst outcomes are seen in those with many chronic diseases (tables 3 and 4). Much of the literature has suggested that multimorbidity is problematic for older people[31] [32] and our finding of very high rates of adverse outcomes in groups with multiple chronic conditions supports this idea.

Previous results on the joint effects of diseases with respect to adverse health outcomes have been mixed. Fried et al[24] in a study of the Women's Health and Ageing Study discovered several synergistic interactions between chronic conditions with respect to the risk of disability that we did not observe; however, the main effects of diseases were less than those found in our study. Data from the Kungsholmen study have shown variations in the rate of disability among individuals suffering from particular combinations of comorbid conditions, with particularly high rates seen in disease

pairs, including dementia, suggesting that the specific conditions suffered are more important than the count of diseases.[33]

On the other hand, our results suggest that the effects of multiple diseases with respect to disability are equal to or less than the combined effects of each individual disease on the individual, rather than there being any synergistic statistical interaction between them. This finding supports previous evidence derived from the development of the sickness impact profile, which suggests that a person's overall level of dysfunction is reflected not by the sum of their dysfunction across domains but by the impact of disease on the maximally affected domain and the number of domains affected.[34] One possible explanation for this discrepancy across studies is the differing age range of the populations used; our population was predominantly middle–aged, whereas those of the Women's Health and Ageing Study and the Kungsholmen studies were older. It is possible that in older cohorts the main effects of single diseases with respect to disabilities are less, which would lead to apparently higher interactions in these groups. Another explanation is that some of the disease pairs previously seen to cause synergistic effects were not examined in our study; for example, owing to limitations of our dataset, we did not specifically explore the effects of stroke, visual impairment or dementia.

Data from the Longitudinal Aging Study Amsterdam found that, similar to our own study, the effect of a single chronic disease on SRH was greater than the effect of subsequent diseases.[20] With respect to QoL, our finding of no synergistic effect is supported by a previous study of 238 individuals recruited from a primary care setting[35] where only two statistically significant interactions between 14 chronic conditions were detected. A study of 4656 participants aged 65 years and older of the KORA-age study discovered only two synergistic interactions between six chronic diseases with respect to health-related QoL, specifically the interactions between coronary disorders and stroke, and coronary disorders and diabetes.[16]

International comparisons

International comparisons can yield important insights into determinants of health[36] and the large disparity between the levels of reported disability and poor SRH in NI and RoI even after adjusting for chronic disease prevalence also warrants further investigation. Several explanations have been proposed for this difference,[17] which confirms a similar observation in a smaller cross-border study of approximately 2000 individuals aged 65 years and over.[18] A higher prevalence of risk factors has been reported in the UK (which includes NI) compared to that in RoI; however, this cannot explain the wide discrepancy between the disability rates. Another possibility is the influence of two different healthcare systems. While older people are more likely to visit their GP in RoI, older people in NI are significantly more

likely to use a wider range of primary care services, including home help and meals on wheels,[17] and it may be that the increased level of service provision increases the likelihood that a disability is reported. It is of note that the reported disability prevalence in an English population (with a similar healthcare system to that in NI), 34% for men and 35% for women,[37] is closer to the rates reported here for NI (44%) than RoI (20%). The prolonged period of civil unrest experienced by the older population of NI may also have contributed to poorer health outcomes.[38]

Strengths and weaknesses of the study

The major strength of our study is the large sample, representative of two national populations. A diverse range of health-related outcomes was explored. However, neither study was specifically designed for the analysis of older populations, and so the measures of multimorbidity and health-related outcome are limited. In particular, comparable questions on mental and cognitive health could not be derived, and disability is represented by a single question. Our multimorbidity index includes major chronic condition groups, but it is likely that many participants also suffered other conditions not included in our analysis. Nevertheless, the list of diseases we used is similar to those employed in other population-based studies, considering the distribution and effect of chronic conditions,[29 39] and represents the chronic diseases with the greatest impact on the older population. Grouping chronic diseases into four groups will have masked some potential interactions between diseases within groups, in particular within the respiratory and cardiovascular groups; however, if synergistic effects between chronic diseases were generally present, we would also expect to see them across groups.

We dichotomised our outcome measures for ease of interpretation, but the results were not substantively different when the full range of outcome responses for SRH and QoL was explored. The single questions we used to measure SRH and QoL are widely used and have face validity; however, it is possible that they are subject to adaptation, whereby those with chronic disease recalibrate their expectations, making comparisons with those without chronic disease problematic.[40] This would have the effect of attenuating estimates of the effect of diseases. It is unlikely that the question regarding disability would be affected in this way, which may explain why the effects of disease on QoL appear to be less than the effects on disability or SRH.

While it is likely that severity of conditions is an important factor in the disease burden of respondents, assessment of self-reported condition severity in community surveys is contentious, and measures of multimorbidity based on simple counts of conditions in a population setting are supported in the literature.[41] Questions on musculoskeletal pain were not identical in SLAN and NIHSWS, although the results of this study

are consistent when both regional datasets are analysed individually. Occupational social class measures can be problematic in postretirement age groups, although our results are consistent with previous studies showing the social gradient in health and disability.[39 42]

CONCLUSION

In the middle-aged population of Ireland, chronic conditions have an equal or reduced impact on the likelihood of disability, poor SRH and poor QoL when they co-occur in the presence of other conditions. It is broadly acceptable to consider conditions independently when estimating their effects on these outcomes in the older population. However, this does not diminish the importance of multimorbidity for the individual. A significant proportion of the population aged 50 years and over across the island of Ireland lives with multimorbidity, and this group is at the highest risk of disability, poor SRH and poor QoL.

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