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RESEARCH

Cluster Randomized Controlled Trial of a Breathing and Relaxation Training Included in Antenatal Education

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ABSTRACT

Objective: To evaluate the effectiveness of the BreLax antenatal education class, which includes breathing and relaxation techniques, to improve childbirth self-efficacy compared with standard antenatal education.

Design: Parallel-group, cluster-randomized controlled trial.

Setting: Hospital-based antenatal classes in Switzerland.

Participants: Pregnant women ($N = 64$: intervention $n = 35$; control $n = 29$) from 32 antenatal education classes randomized at the class level (16 intervention classes and 16 control classes).

Methods: All participants attended an 8-hour antenatal education class. We assessed childbirth self-efficacy as the primary outcome using validated measures and maternal and neonatal outcomes. The intervention group also received structured and guided breathing and relaxation training supported by digital tools.

Results: Childbirth self-efficacy improved significantly from baseline to after intervention in both groups (intervention: +14.1 points, $p < .001$; control: +11.2 points, $p = .00$), with no significant interaction between time and study arm ($p = .58$). Greater frequency of self-practice of the breathing and relaxation technique taught in the BreLax intervention predicted greater self-efficacy ($\beta = -6.16$, $p = .05$). We observed no group differences for childbirth experience or neonatal outcomes except for perceived safety, which was slightly higher in the control group ($p = .04$).

Conclusion: Antenatal education that includes structured breathing and relaxation techniques, such as the BreLax intervention, can support the development of childbirth self-efficacy. Greater frequency of self-practice of these techniques was associated with higher self-efficacy, which underscores the importance of repeated and supported practice. Future researchers should further examine the optimal intensity of practice, the role of partner involvement, and the potential of digital tools to facilitate sustained engagement with breathing and relaxation techniques.

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Pregnancy and childbirth are major life events that lead to considerable physical, emotional, and social changes for women. Antenatal education classes (AECs) provide expectant women and their partners with knowledge and coping skills that promote confidence and preparedness for birth and the transition to parenthood (Ahldén et al., 2012; Alizadeh-Dibazari et al., 2023). Typical AECs include information on pregnancy, labor, and the postnatal period. Although breathing and relaxation techniques are often mentioned, this usually involves brief instruction or general recommendations rather than structured guided practice. As a result, opportunities to actively develop and consolidate these skills remain limited (Leutenegger et al., 2022). These elements promote physical preparedness for childbirth and empower women by supporting emotional and physiologic self-regulation and encouraging active participation in labor and birth (Zaman et al., 2025).

Researchers showed that structured antenatal classes can decrease childbirth fear, improve emotional readiness, and strengthen maternal confidence (Alizadeh-Dibazari et al., 2023; Citak Bilgin et al., 2020). In studies involving women with high levels of fear of childbirth (FOC), researchers reported beneficial associations between breathing and relaxation training and

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Evidence-based antenatal education classes are limited, and few integrate structured and guided breathing and relaxation techniques in a coherent theoretical framework for behavioral change.

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maternal outcomes. For example, Boaviagem et al. (2017) reported reduced anxiety and improved emotional well-being following antenatal relaxation training, and Lönnberg et al. (2020) found that targeted breathing and relaxation interventions were associated with more positive birth experiences among women with elevated FOC. Similarly, Salmela-Aro et al. (2012) reported improvements in psychological well-being and coping among women who participated in antenatal interventions to address childbirth-related fear. Beyond fear reduction, regular practice of breathing and relaxation has been associated with lower stress and depression symptoms and greater psychological resilience during late pregnancy (Abera et al., 2024; Byrne et al., 2014).

Literature Review

Evidence regarding neonatal outcomes remains limited and inconsistent (Hong et al., 2021; Zaman et al., 2025). For example, in a systematic review of 40 studies evaluating the impact of antenatal education on maternal and neonatal outcomes, Zaman et al. (2025) reported no significant effects on neonatal outcomes. Specifically, antenatal education was not associated with differences in Apgar scores at 1 and 5 min, infant birth weight, or the incidence of low birth weight compared with control conditions. However, in a prospective interventional study in hospital-based maternity units in Iraq involving 112 healthy pregnant women, Abdullah and Najib (2020) compared those who took part in structured antenatal exercise sessions ($n = 56$) with those who received standard antenatal care without an exercise component ($n = 56$). Newborns in the intervention group had significantly higher Apgar scores and lower incidences of neonatal complications and admission to the NICU, whereas birth weight did not differ significantly between the groups. However, evidence on the effects of antenatal education on neonatal outcomes remains limited and inconsistent. Although some studies report benefits in specific contexts, systematic reviews and meta-analyses generally show no significant effects on core neonatal indicators such as Apgar scores, birth weight, and gestational age (Hong et al., 2021; Zaman et al., 2025).

Antenatal education can have a beneficial effect on childbirth self-efficacy and various maternal outcomes (Ferri et al., 2024). Increased childbirth self-efficacy was linked to better coping during labor, lower levels of childbirth-related anxiety, and more positive birth experiences (Levett et al., 2016). In addition, AECs were associated with greater perceived preparedness (Shimpuku et al., 2019), enhanced maternal confidence (Shorey et al., 2022), and improved satisfaction with childbirth (Merriel et al., 2024), although reported effects vary depending on class structure and population characteristics (Zaman et al., 2025).

Traditionally, the development of AECs has been guided more by the experience and discretion of midwife educators than by systematic, theory-driven frameworks. Although existing evidence suggests that AECs can positively influence childbirth self-efficacy and women's perceptions about labor (Abbasi et al., 2018; Levett et al., 2016), these effects were often observed in heterogeneous and variably structured settings. The explicit integration of theories on self-efficacy into the design of AECs remains rare (Zaman et al., 2025) despite the central role that self-efficacy plays in managing labor pain and emotional regulation during childbirth (AlSomali et al., 2023).

Bandura's (1977) theory of self-efficacy provides a well-established framework for understanding how individuals develop confidence in their ability to manage challenging situations such as childbirth. Self-efficacy is shaped through mastery experiences, verbal encouragement, emotional regulation, and vicarious learning mechanisms that are highly relevant to antenatal education and the acquisition of coping skills for labor. Prior researchers found that higher childbirth self-efficacy was associated with lower FOC (Çankaya & Şimşek, 2021), improved coping (Byrne et al., 2014), and more positive birth experiences (Akca et al., 2017). Therefore, we used Bandura's self-efficacy theory to inform the design of the BreLax AEC and to guide the selection of childbirth self-efficacy as the primary outcome rather than to formally test the theory itself.

Evidence-based, theory-informed AECs that combine breathing and relaxation with structured behavioral reinforcement remain rare. Moreover, the effective application of these techniques during labor requires repetition, adaptation, and reinforcement throughout pregnancy (Avignon et al., 2023). Recent evidence underscores the critical role of consistent practice to improve the

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efficacy of breathing techniques. In clinical and experimental settings, repeated training and rehearsal of these strategies were associated with reduced anxiety levels and shorter duration of labor (Cicek & Basar, 2017; Karkada et al., 2023). How often women practice breathing and relaxation techniques in the antenatal period may be a key factor in achieving positive outcomes, which underscores the need to support regular home application beyond initial instruction.

Digital tools can strengthen antenatal education by providing flexibility, reminders, and continuous access to practice materials. When embedded in structured, professionally guided frameworks, digital tools can enhance learning, support self-efficacy development, and facilitate ongoing engagement (Espinosa Cifuentes et al., 2022; Whitworth et al., 2024). However, digital tools should complement, not replace, in-person instruction and midwife support (Middleton et al., 2022).

We created and evaluated a comprehensive AEC grounded in self-efficacy theory called BreLax. This AEC integrates a personalized approach to breathing and relaxation, uses digital tools for home practice, and includes behavioral prompts. We designed the BreLax AEC to be easily scalable, accessible, and aligned with current antenatal care frameworks. Our primary objective was to evaluate the effectiveness of the BreLax AEC to improve childbirth self-efficacy compared with standard antenatal education. Secondary objectives were to (a) examine how the BreLax AEC affects maternal outcomes such as childbirth experience, pain management, mode of birth, duration of labor, and maternal–infant bonding; (b) evaluate the influence of the BreLax AEC on neonatal outcomes such as birth weight, 5-min Apgar score, and umbilical cord pH levels; and (c) explore women's perceptions of the intervention's applicability and their use of the breathing and relaxation techniques during labor and birth.

Methods

Design

We developed the BreLax AEC according to the Medical Research Council framework for complex interventions (Craig et al., 2008) and informed it with Bandura's (1977) self-efficacy theory and the COM-B model of behavior change, which cites capability (C), opportunity (O), and motivation (M) as three key factors capable of changing behavior (B) (Michie et al., 2011, 2013). We used Bandura's self-efficacy theory to guide the development of the intervention and the selection of the primary outcome. Q9

We used a single-blind, cluster-randomized controlled trial to compare an AEC including structured and guided breathing and relaxation training with a standard AEC. Each cluster represented one antenatal class. Both groups attended an 8-hour program that covered pregnancy, labor, and postnatal topics. The intervention group also received structured breathing and relaxation training that was supported by digital tools and regular reminders. We used Bandura's (1977) self-efficacy theory to guide the development of the intervention and the selection of the primary outcome.

We performed cluster randomization using the sequentially numbered, opaque, sealed envelope method. A study midwife not involved in class instruction opened envelopes and assigned each class to the intervention or control group. During the 12-month study period, we conducted 32 of 35 scheduled antenatal classes (16 per arm). We based the sample size estimation on effect size estimates from a randomized trial of a self-efficacy-enhancing childbirth preparation program (Ip et al., 2009). A moderate effect (Cohen's $d = 0.75$), 80% power, and $\alpha = .05$ were assumed. Using G*Power 3.1, 29 women per group were required. Allowing 20% attrition yielded a target of 35 per group ($N = 70$). Because randomization occurred at the class (cluster) level with a mean of approximately 2 women per cluster, the design effect was expected to be negligible.

The study met Swiss Category A criteria for low-risk human research. We obtained approval from the Canton Zurich ethical committee (SNCTP000005672). The trial was registered with ClinicalTrials.gov (NCT06003946). All women gave written informed consent.

Setting

We conducted the study at a Swiss hospital with approximately 2,000 annual births. AECs offered at the hospital are attended by about 240 expectant women and their partners annually.

Participants

We considered women eligible if they were 18 years or older; had singleton, low-risk pregnancies at 10 to 30 weeks gestation; were planning

vaginal birth; were receiving antenatal care; and were fluent in German. We excluded women who scored greater than 60 on the Fear of Birth Scale (FOBS; Haines et al., 2011) to ensure focus on women without elevated psychological risk. This approach differs from previous intervention studies that specifically targeted women with high levels of FOC or psychological distress (Boaviagem et al., 2017; Çankaya & Şimşek, 2021). Antenatal education classes were offered as condensed weekend classes delivered as full-day sessions or as weekday classes distributed across several shorter sessions. Among the 64 women included in the analysis, 50 attended weekend classes and 14 attended weekday classes. Recruitment occurred through antenatal clinics, obstetric and midwifery practices, social media, and a dedicated study website. Interested women could register online and were contacted with study details. Written informed consent was obtained before class participation (Figure 1).

Data Collection

The study was conducted from December 2023 to December 2024. We collected data at multiple time points (T) throughout the study. After providing written informed consent, participants completed a baseline questionnaire before attending the AEC (T0). Baseline data included demographic and pregnancy-related characteristics as well as childbirth-related anxiety assessed with the FOBS.

Following cluster allocation, participants attended the intervention or control AEC. Participants in the control group attended the standard hospital-based antenatal class that reflected standard care. The 8-hour class covered physiologic processes of pregnancy and childbirth, stages of labor, pain relief options, medical interventions, and the postnatal period and was delivered by certified midwives using lectures, group discussions, and printed educational materials. No structured breathing practice, home exercises, or digital support materials were included. Participants in the intervention group attended the standard AEC supplemented with structured breathing and relaxation training, including guided in-class practice and digital tools with reminders to support home practice. A detailed description is available in the study protocol (Leutenegger et al., 2024).

We collected data at three different time points. Following participation in the AEC, the participants completed a follow-up questionnaire (T1). We used this questionnaire to assess childbirth self-efficacy and practice engagement. We extracted birth-related outcomes, including mode of birth, duration of labor, birth weight, 5-min Apgar score, and umbilical cord blood pH, from hospital records (T2). We administered a final questionnaire 2 to 4 weeks postpartum (T3) to assess childbirth experience and women's perceptions of the breathing and relaxation techniques used during birth.

The midwives who provided the classes attended a 2-hour workshop led by the study's principal investigator, a midwife and researcher with extensive experience in antenatal education and behavioral intervention development. Each educator was provided with a brief manual outlining the components of the class and study procedures.

Measures

The primary outcome was childbirth self-efficacy, assessed with the Childbirth Self-Efficacy Inventory (CBSEI-32), grounded in Bandura's (1977) theory. The inventory is used to examine antenatal preparation, anxiety, pain tolerance, and labor perceptions using a Likert scale from 1 (*strongly agree*) to 10 (*strongly disagree*). The German version shows high internal consistency (self-efficacy expectation $\alpha = .86$; outcome expectation $\alpha = .82$; Schmidt et al., 2016).

Secondary outcomes included childbirth experience, pain intensity, mode of birth, duration of labor, maternal–infant bonding, birth weight, 5-min Apgar score, umbilical cord blood pH, and women's perceptions of and use of the breathing and relaxation techniques during labor and birth. We assessed childbirth experience using the Childbirth Experience Questionnaire (CEQ 2.0), which includes four dimensions: own capacity, perceived safety, support, and participation (Dencker et al., 2010). These dimensions are rated on a 4-point Likert scale with visual analog scales for pain, control, and safety. The German version of the CEQ 2.0 has demonstrated good psychometric properties. In validation studies, internal consistency was good across most subscales (McDonald's $\omega > .70$), with slightly lower reliability for the participation subscale (McDonald's $\omega = .67$; Pedersen et al., 2021). We measured childbirth-related anxiety at baseline using the FOBS, a two-item visual analog scale that includes ratings for feelings from *calm* to *anxious* and from *no anxiety* to *severe anxiety* for an average score (Hildingsson et al., 2017).

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Analysis

We tested group equivalence at baseline using *t* and χ^2 tests. We used a linear mixed-effects model to examine the effects of time (T_0–T_1), group, and interaction on self-efficacy. Significance was set at $p < .05$ (two-tailed). We conducted additional analyses to examine associations among practice frequency, mode of birth, pain, and childbirth experience. We used a modified intention-to-treat approach including all participants with available data.

Results

Sample Characteristics

We screened 240 women, and 68 met the inclusion criteria; of these, 4 (5.9%) were excluded because of elevated FOBS scores (>60). The final analytic sample comprised 64 participants

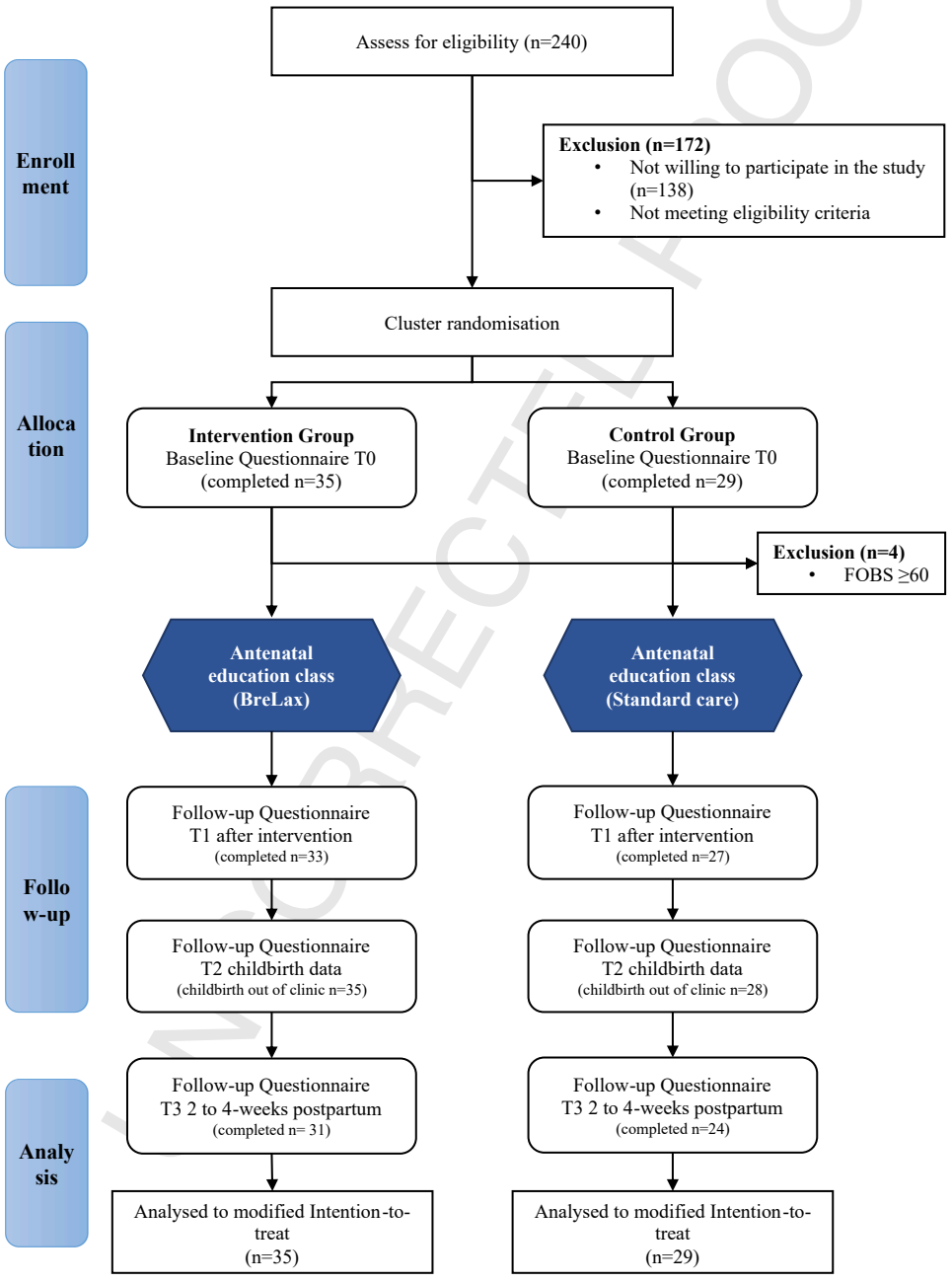

Figure 1. Flowchart of participants. *Note.* FOBS = Fear of Birth Scale.

Antenatal education can reduce fear of childbirth and improve maternal outcomes, but consistent practice and digital tools are often lacking in traditional class models.

(intervention $n = 35$; control $n = 29$). Participants were comparable at baseline with respect to age, gestational age, parity, and educational level (Table 1). Most participants were nulliparous.

Overall, 51 participants (79.7%) attended condensed weekend antenatal classes and 13 (20.3%) attended weekday evening classes. The distribution was similar across study arms (intervention: 28/35 weekend, 7/35 weekday; control: 23/29 weekend, 6/29 weekday). Birth-related characteristics were comparable between groups (Table 2). No significant between-group differences were observed for mode of birth, gestational age at birth, duration of labor, or pain intensity during childbirth.

Self-Efficacy

Childbirth self-efficacy increased over time in both groups. However, the linear mixed-effects model showed no significant group-by-time interaction, indicating that the intervention did not lead to greater improvements compared with standard antenatal education. Exploratory analyses showed no differences in childbirth self-efficacy by mode of birth. More frequent practice of the breathing and relaxation techniques was associated with higher self-efficacy scores (Table 3).

Maternal and Neonatal Outcomes

We observed no significant between-group differences for maternal or neonatal outcomes. Neonatal outcomes, including fetal bonding, birth weight, Apgar scores, and umbilical cord blood pH, did not differ significantly between groups (Table 4).

Results from the CEQ 2.0 showed comparable scores between groups across most dimensions; perceived safety was slightly higher in the control group (Table 5). Across the total sample, higher pain intensity was associated with a less positive childbirth experience. Additional exploratory analyses indicated associations among pain intensity, perceived control, safety, and participation.

Attendance in condensed weekend AECs was associated with lower childbirth experience scores compared with weekday classes ($\beta = -6.29$, $p = .025$). Greater practice frequency showed a marginal positive association with childbirth experience (see Figure 2).

Table 1: Characteristics of Participants ($N = 64$)

	Intervention (BreLax)		Control	
Characteristic	*n*	%	*n*	%
Maternal Age (years (*M*, *SD*))	33.5 (4.4)		31.3 (4.3)	
First Pregnancy	30	85.7	26	89.7
Second and More Pregnancies	4	11.4	3	10.3
Nationality				
Switzerland	25	71.4	25	86.2
Germany	4	11.4	3	10.3
Italy	2	5.7	0	
Sri Lanka	1	2.9	0	
Others	2	5.7	1	3.4
Living Situation				
Living with a partner	34	97.1	29	100
Living alone	0		0	
Estimation of Gross Income				
Very good income	13	37.1	10	34.5
Good income	15	42.9	17	58.6
Moderate income	4	11.4	2	6.9
Not specified	2	5.7	0	
Antenatal Care by:				
Obstetrician	33	94.3	28	96.6
Obstetrician and midwife	2	5.7	1	3.4
AEC Format				
Weekend class (full day)	28	80	23	79.3
Week class (>4 weeks)	7	20	6	20.7

Note. Percentages might not total to 100 because of missing values or rounding. AEC = antenatal education class.

Evaluation of the Adherence to the Intervention

Most participants indicated that they used breathing techniques during labor. In the control group, 79% reported using at least one breathing

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Table 2: Birth-Related Characteristics

Characteristic	Intervention (BreLax) (n = 35) M	SD	Control (n = 29) M	SD	t	p
Gestational Age at Birth (weeks)	39.59	1.40	39.65	1.82	0.12	.90
Missing	1		2			
Duration of Labor (hours)	7.35	4.3	8.20	4.5	−0.71	.48
Missing						
VAS During Childbirth (CEQ 2.0 Items 23–25)	65.64	15.94	69.21	12.91	0.85	.40
Missing	9		8			
	N	%	n	%	χ^2	p
Mode of Birth						
Vaginal birth	20	57.1	18	62.1	0.13	.72
Caesarean birth	14	40.0		31.0		
Missing	1		2			
Epidural Analgesia						
Yes	18	54.5	16	59.3	0.01	.92
No	15	45.5	11	40.7		
Missing	2		2			
Patient-Controlled Analgesia						
Yes	0		1	4.0	0.01	.92
No	33	100.0	26	96.0		
Missing	2		2			

Note. Percentages might not total to 100 because of missing values or rounding. VAS = visual analog scale; CEQ 2.0 = Childbirth Experience Questionnaire 2.0.

technique compared with 90% in the intervention group. General awareness breathing was reported by 68% and 74%, respectively, and deep abdominal breathing was reported by 52% and 51%. Individualized prolonged exhalation was more commonly used in the intervention group

Table 3: Changes in Childbirth Self-Efficacy Over Time by Study Group: Linear Mixed-Effects Model Results

Predictor	*β*	*SE*	*df*	*t*	*p*	95% *CI*
Intercept	203.77	11.84	61	1.77	.08	[−26.7, 434.2]
Time (T1 vs. T0)	9.33	3.48	61	2.68	.01	[2.37, 16.29]
Group (Intervention vs. Control)	−10.58	5.68	59	−1.86	.07	[−21.91, 0.75]
Education	−0.54	1.67	59	−0.32	.75	[−3.88, 2.80]
Maternal Age	−0.92	0.58	59	−1.59	.12	[−2.08, 0.24]
Time × Group	2.31	4.74	61	0.49	.63	[−7.17, 11.79]

Note. Time represents the change from baseline (T0) to follow-up (T1). Group indicates intervention versus control. The model included a random intercept for participant (study_id) and was adjusted for maternal age and education. *β* = regression coefficient; *CI* = confidence interval.

Table 4: Neonatal Outcomes

Characteristic	Intervention (BreLax) ($n = 35$)		Control ($n = 29$)			
	M	*SD*	*M*	*SD*	χ^2	*p*
Fetal Bonding						
Yes	26	74.3	18	62.1	0.31	.57
No	8	22.9	9	31.0		
Missing	1		2			
Birth Weight						
<2500 g	0		2	7.0	0.79	.37
≥2500 g	34	97.1	25	86.2		
Missing	1		2			
Apgar Score at 5 min						
>7	31	88.6	25	86.2	0.0	1.0
<7	3	8.6	2	6.9		
Missing	1		2			
Umbilical Cord pH						
>7.10	25	71.4	20	69.0	0.02	.88
<7.10	1	3.0	2	6.9		
Missing	9		7			

Note. Group differences were tested using χ^2 tests. Missing values represent participants with unavailable data for the respective outcome. Apgar scores refer to the 5-min assessment.

(55%) than in the control group (26%). Use of the digital tools varied. Overall, 82% of participants stated that digital reminders were helpful, whereas 38% said they would have liked more frequent reminders.

Discussion

The BreLax AEC was developed and tested to explore the potential of structured and guided breathing and relaxation training to enhance childbirth self-efficacy.

Table 5: Results From Childbirth Experience Questionnaire 2.0

Dimension	Intervention (BreLax) ($n = 35$)		Control ($n = 29$)				
	M	SD	M	SD	*MD*	95% *CI*	*p*
Own Capacity	23.77	9.36	24.58	7.06	0.81	[-3.63 - 5.25]	.72
Professional Support	12.65	4.96	13.13	3.03	0.48	[-1.70 - 2.66]	.66
Participation	7.90	3.05	8.21	2.64	0.31	[-1.23 - 1.84]	.69
Perceived Safety	16.74	7.08	19.71	3.09	2.97	[0.10 - 5.83]	.04

Note. Scores are derived from the Childbirth Experience Questionnaire 2.0, including the dimensions own capacity, professional support, participation, and perceived safety. Positive *MD* values indicate higher scores in the control group. *MD* = XXX; *CI* = confidence interval. Q16

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Although no significant between-group differences were observed, both groups showed significant gains in childbirth self-efficacy from baseline to follow-up. Our finding underscores the overall positive effect of antenatal education on women's confidence for childbirth and aligns with meta-analytic evidence demonstrating that antenatal education enhances self-efficacy across diverse populations and formats (Zamani et al., 2019).

One possible explanation for the absence of between-group differences is that both study arms received structured, hospital-based antenatal education delivered by qualified midwives. Standard antenatal education already incorporates key mechanisms known to foster self-efficacy, including knowledge acquisition, anticipatory guidance, and opportunities for social exchange, which may have been sufficient to promote improvements in both groups. Rather than group allocation alone, differences in childbirth self-efficacy appeared to be related to individual engagement with the breathing and relaxation techniques. Although both groups received comparable information, only the intervention group engaged in structured skill application supported by digital tools, which reflected a key distinction between passive information transfer and active skill acquisition consistent with behavior change theory. The finding that more frequent practice was associated with higher self-efficacy supports the assumption that mastery experiences and repeated rehearsal, central mechanisms in Bandura's self-efficacy theory, are critical for strengthening confidence (Shorey et al., 2022; Tabib et al., 2026).

We found no significant differences between the groups related to childbirth experience outcomes except greater perceived safety among the control group. This finding may reflect higher expectations among women in the intervention group or contextual influences related to institutional care rather than effects of the educational content itself. The identified inverse relationship between perceived pain and the overall childbirth experience aligns with earlier studies in which higher levels of pain were linked to less positive childbirth experiences. For instance, in a validation study of the CEQ involving 377 Danish women undergoing induced labor, Boie et al. (2020) found that childbirth experience scores Q12 were significantly related to labor characteristics and participants' perceptions of the birth process. Together, these results highlight the importance of effective coping strategies for managing labor pain during childbirth. Although the intervention might have supported women's pain management, perceived safety seems to depend

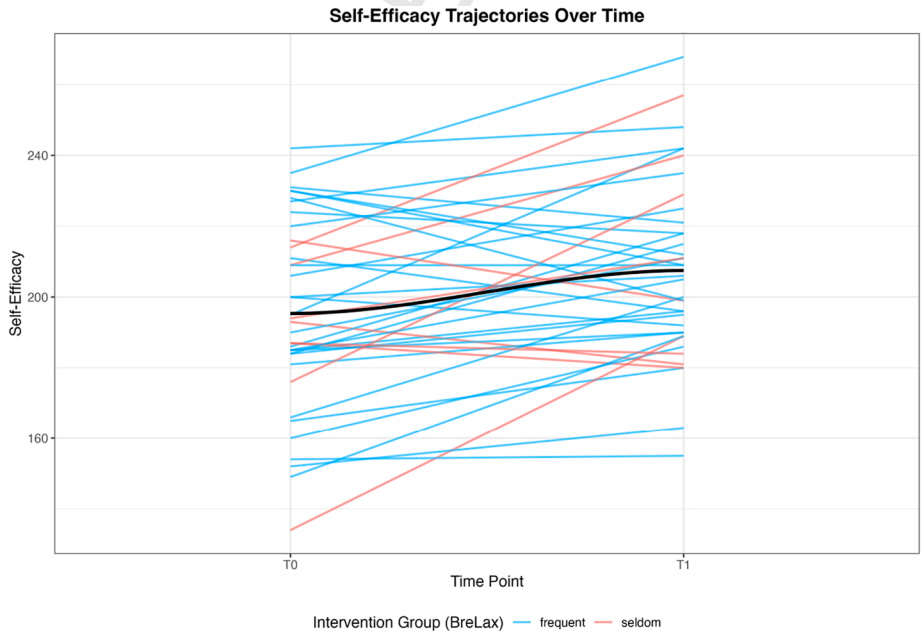

Figure 2. Association between practice frequency of the breathing and relaxation technique and childbirth experience.

The study team developed and tested a theory-based antenatal education class that included breathing and relaxation techniques and digital tools to improve childbirth self-efficacy.

more heavily on institutional and systemic conditions, such as the presence of continuous midwifery support, hospital policies on pain relief, and how intrapartum care is organized, than on the educational content itself. For instance, neonatal outcomes (e.g., birth weight, Apgar scores) were comparable between groups, which supports the safety of the BreLax AEC. Consistent with previous studies, our findings suggest that neonatal outcomes are more strongly influenced by continuity of midwifery care and supportive care systems than by antenatal education formats alone (Renfrew et al., 2014; Sandall et al., 2024).

Participants indicated that digital tools, such as reminders and audiovisual instructions, facilitated their engagement with the breathing and relaxation exercises. This is consistent with behavioral science theories in which it is proposed that prompts, cues, and guided practice can enhance adherence to self-regulation techniques (Michie et al., 2013). Comparable benefits were observed in research on digitally supplemented antenatal education in which digital resources and reminders supported the consolidation of learning and continued practice between in-person sessions (Whitworth et al., 2024). The condensed weekend course format may have limited opportunities for behavioral reinforcement and reflective learning given that spaced learning approaches are more conducive to skill integration (Hattie & Donoghue, 2016). Partner participation was limited despite evidence that partner involvement can strengthen coping capacity and childbirth self-efficacy (Schwartz et al., 2015; Shakarami et al., 2021). Future interventions should actively integrate partners and employ interactive, theory-driven approaches that foster shared coping and experiential learning (Dagla et al., 2023).

Limitations

Several limitations should be considered. First, this study was carried out in a single hospital and involved a relatively small number of participants, which may restrict the extent to which the results can be generalized. Second, because participation was voluntary, selection bias may have occurred. Furthermore, the relatively high educational and socioeconomic levels of the women might have led to ceiling effects in childbirth self-efficacy. We encountered challenges during the recruitment process that resulted in a sample size that fell below the initial plan. Even though randomization was applied at the class level, the small average cluster size (approximately 2 women) led to an insignificant design effect and consequently caused only a slight decrease in statistical power (Hayes & Moulton, 2017). Furthermore, women with elevated FOC were excluded based on FOBS scores, which limited the applicability of the findings to populations with higher psychological distress. In previous intervention studies targeting women with high levels of FOC, researchers reported beneficial effects of breathing, relaxation, and coping-focused antenatal interventions on maternal psychological outcomes and birth experiences (Boaviagem et al., 2017; Cicek & Basar, 2017). Future researchers therefore should examine whether theory-informed AECs such as BreLax are similarly beneficial for more diverse populations, including women with higher levels of childbirth fear or psychosocial vulnerability.

Implications

Future researchers should investigate the potential of hybrid models that blend digital and in-person components in relationship-centered antenatal care. To ensure success, developers of AEC programs need to incorporate psychological behavior change theories alongside midwifery principles such as continuity, emotional support, and personalized care. Digital tools should enhance comprehensive care rather than serve as standalone options. Identifying subgroups that benefit from specific practices can help to develop tailored methods. It is essential to include partners in antenatal education. Long-term studies are required to examine the relationship between childbirth self-efficacy and maternal adjustment. In our study, we emphasize the need for repeated practice, behavioral prompts, and digital support to build confidence during birth. We support the development of scalable, theory-based, and personalized interventions. As a low-threshold antenatal education model supported by digital tools, BreLax shows significant potential for broad implementation, improving personalized antenatal education, and facilitating smoother transitions into parenthood.

Conclusion

Our cluster-randomized controlled trial of AECs underscores the potential benefits of theory-

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driven childbirth education. The BreLax AEC grounded in Bandura's self-efficacy theory, the COM-B model, and the Medical Research Council framework indicate that incorporating structured breathing and relaxation exercises into antenatal classes may enhance childbirth self-efficacy and women's confidence. Our results also emphasize the possible importance of repeated practice, behavioral cues, and digital tools in promoting sustained use of breathing and relaxation strategies during labor.

Declaration Of Ai And Ai-Assisted Technologies In The Writing Process

During the preparation of this work, the authors used Writefull and DeepL Translator to improve language clarity and fluency. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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CONFLICT OF INTEREST

The authors report no conflicts of interest or relevant financial relationships.

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REFERENCES

Abbasi, P., Charandabi, S. M.-A., & Mirghafourvand, M. (2018). Comparing the effect of e-learning and educational booklet on the childbirth self-efficacy: A randomized controlled clinical trial. *The Journal of Maternal-Fetal & Neonatal Medicine, 31*(5), 644–650. https://doi.org/10.1080/14767058.2017.1293031

Abdullah, W. H., & Najib, B. M. (2020). Effect of antenatal exercise teaching program on neonatal outcomes during delivery in Erbil, Iraq. *Medico-Legal Update, 20*(1), 510–515. https://doi.org/10.37506/v20/i1/2020/mlu/194373

Abera, M., Hanlon, C., Daniel, B., Tesfaye, M., Workicho, A., Girma, T., … Wells, J. C. K. (2024). Effects of relaxation interventions during pregnancy on maternal mental health, and pregnancy and newborn outcomes: A systematic review and meta-analysis. *PLoS One, 19*(1), Article e278432. https://doi.org/10.1371/journal.pone.0278432

Ahldén, I., Ahlehagen, S., Dahlgren, L. O., & Josefsson, A. (2012). Parents' expectations about participating in antenatal parenthood education classes. *The Journal of Perinatal Education, 21*(1), 11–17. https://doi.org/10.1891/1058-1243.21.1.11

Akca, A., Esmer, A. C., Ozyurek, E. S., Aydin, A., Korkmaz, N., Gorgen, H., & Akbayir, O. (2017). The influence of the systematic birth preparation program on childbirth satisfaction. *Archives of Gynecology and Obstetrics, 295*(5), 1127–1133. https://doi.org/10.1007/s00404-017-4345-5

Alizadeh-Dibazari, Z., Abdolalipour, S., & Mirghafourvand, M. (2023). The effect of prenatal education on fear of childbirth, pain intensity during labour and childbirth experience: A scoping review using systematic approach and meta-analysis. *BMC Pregnancy and Childbirth, 23*(1), Article 541. https://doi.org/10.1186/s12884-023-05867-0

AlSomali, Z., Bajamal, E., & Esheaba, O. (2023). The effect of structured antenatal education on childbirth self-efficacy. *Cureus, 15*(5), Article 39285. https://doi.org/10.7759/cureus.39285

Avignon, V., Gaucher, L., Baud, D., Legardeur, H., Dupont, C., & Horsch, A. (2023). What do mothers think about their antenatal classes? A mixed-method study in Switzerland. *BMC Pregnancy and Childbirth, 23*(1), Article 741. https://doi.org/10.1186/s12884-023-06049-8

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Boaviagem, A., Melo Junior, E., Lubambo, L., Sousa, P., Aragão, C., Albuquerque, S., & Lemos, A. (2017). The effectiveness of breathing patterns to control maternal anxiety during the first period of labor: A randomized controlled clinical trial. *Complementary Therapies in Clinical Practice, 26*, 30–35. https://doi.org/10.1016/j.ctcp.2016.11.004

Byrne, J., Hauck, Y., Fisher, C., Bayes, S., & Schutze, R. (2014). Effectiveness of a mindfulness-based childbirth education pilot study on maternal self-efficacy and fear of childbirth. *Journal of Midwifery & Women's Health, 59*(2), 192–197. https://doi.org/10.1111/jmwh.12075

Çankaya, S., & Şimşek, B. (2021). Effects of antenatal education on fear of birth, depression, anxiety, childbirth self-efficacy, and mode of delivery in primiparous pregnant women: A prospective randomized controlled study. *Clinical Nursing Research, 30*(6), 818–829. https://doi.org/10.1177/1054773820916984

Cicek, S., & Basar, F. (2017). The effects of breathing techniques training on the duration of labor and anxiety levels of pregnant women. *Complementary Therapies in Clinical Practice, 29*, 213–219. https://doi.org/10.1016/j.ctcp.2017.10.006

Citak Bilgin, N., Ak, B., Ayhan, F., Kocyigit, F., Yorgun, S., & Topcuoglu, M. A. (2020). Effect of childbirth education on the perceptions of childbirth and breastfeeding self-efficacy and the obstetric outcomes of nulliparous women. *Health Care for Women International, 41*(2), 188–204. https://doi.org/10.1080/07399332.2019.1672171

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M. (2008). Developing and evaluating complex interventions: The new Medical Research Council guidance. *BMJ, 337*, Article a1655. https://doi.org/10.1136/bmj.a1655

Dagla, C., Antoniou, E., Sarantaki, A., Iliadou, M., Mrvoljak-Theodoropoulou, I., Andersson, E., & Dagla, M. (2023). The effect of antenatal education on expectant fathers' attitudes toward breastfeeding and attachment to the fetus. *Nursing Reports, 13*(1), 243–254. https://doi.org/10.3390/nursrep13010023

Dencker, A., Taft, C., Bergqvist, L., Lilja, H., & Berg, M. (2010). Childbirth Experience Questionnaire (CEQ): Development and evaluation of a multidimensional instrument. *BMC Pregnancy and Childbirth, 10*(1), Article 81. https://doi.org/10.1186/1471-2393-10-81

Espinosa Cifuentes, M., Artieta-Pinedo, I., Paz-Pascual, C., Bully-Garay, P., & García-Alvarez, A. (2022). EMAeHealth, a digital

tool for the self-management of women's health needs during pregnancy, childbirth and the puerperium: Protocol for a hybrid effectiveness-implementation study. *BMJ Open, 12*(9), Article e55031. https://doi.org/10.1136/bmjopen-2021-055031

Ferri, A., Sutcliffe, K. L., Catling, C., Newnham, E., & Levett, K. M. (2024). Antenatal education—Putting research into practice: A guideline review. *Midwifery, 132*, Article 103960. https://doi.org/10.1016/j.midw.2024.103960

Haines, H., Pallant, J. F., Karlström, A., & Hildingsson, I. (2011). Cross-cultural comparison of levels of childbirth-related fear in an Australian and Swedish sample. *Midwifery, 27*(4), 560–567. https://doi.org/10.1016/j.midw.2010.05.004

Hattie, J. A. C., & Donoghue, G. M. (2016). Learning strategies: A synthesis and conceptual model. *NPJ Science of Learning, 1*(1), Article 16013. https://doi.org/10.1038/npjscilearn.2016.13

Hayes, R. J., & Moulton, L. H. (2017). *Cluster randomised trials* (2nd ed.). Chapman and Hall/CRC. https://doi.org/10.4324/9781315370286

Hildingsson, I., Haines, H., Karlström, A., & Nystedt, A. (2017). Presence and process of fear of birth during pregnancy—Findings from a longitudinal cohort study. *Women and Birth, 30*(5), e242–e247. https://doi.org/10.1016/j.wombi.2017.02.003

Hong, K., Hwang, H., Han, H., Chae, J., Choi, J., Jeong, Y., … Lee, K. J. (2021). Perspectives on antenatal education associated with pregnancy outcomes: Systematic review and meta-analysis. *Women and Birth, 34*(3), 219–230. https://doi.org/10.1016/j.wombi.2020.04.002

Ip, W.-Y., Tang, C. S., & Goggins, W. B. (2009). An educational intervention to improve women's ability to cope with childbirth. *Journal of Clinical Nursing, 18*(15), 2125–2135. https://doi.org/10.1111/j.1365-2702.2008.02720.x

Karkada, S. R., Noronha, J. A., Bhat, S. K., Bhat, P., & Nayak, B. S. (2023). Effectiveness of antepartum breathing exercises on the outcome of labour: A randomized controlled trial. *F1000Research, 11*, Article 159. https://doi.org/10.12688/f1000research.75960.3

Leutenegger, V., Grylka-Baeschlin, S., Wieber, F., Daly, D., & Pehlke-Milde, J. (2022). The effectiveness of skilled breathing and relaxation techniques during antenatal education on maternal and neonatal outcomes: A systematic review. *BMC Pregnancy and Childbirth, 22*(1), Article 856. https://doi.org/10.1186/s12884-022-05178-w

Leutenegger, V., Wieber, F., Daly, D., Sultan-Beyer, L., Bagehorn, J., & Pehlke-Milde, J. (2024). Study protocol of a breathing and relaxation intervention included in antenatal education: A randomised controlled trial (BreLax study). *PLoS One, 19*(10), Article e308480. https://doi.org/10.1371/journal.pone.0308480

Levett, K. M., Smith, C. A., Bensoussan, A., & Dahlen, H. G. (2016). The Complementary Therapies for Labour and Birth Study making sense of labour and birth—Experiences of women, partners and midwives of a complementary medicine antenatal education course. *Midwifery, 40*, 124–131. https://doi.org/10.1016/j.midw.2016.06.011

Lönnberg, G., Jonas, W., Unternaehrer, E., Bränström, R., Nissen, E., & Niemi, M. (2020). Effects of a mindfulness based childbirth and parenting program on pregnant women's perceived stress and risk of perinatal depression—Results from a randomized controlled trial. *Journal of Affective Disorders, 262*, 133–142. https://doi.org/10.1016/j.jad.2019.10.048

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., & Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine, 46*(1), 81–95. https://doi.org/10.1007/s12160-013-9486-6

Michie, S., van Stralen, M. M., & West, R. (2011). The Behaviour Change Wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science, 6*, Article 42. https://doi.org/10.1186/1748-5908-6-42

Middleton, N., Hadjigeorgiou, E., Kolokotroni, O., Christodoulides, V., Koliandri, I., Nicolaou, C., … Kronson, S. (2022). Identifying barriers to the educational role of midwives in Cyprus and defining determinants in behaviour terms using the Behaviour Change Wheel: A mixed-method formative study. *BMC Health Services Research, 22*(1), Article 1233. https://doi.org/10.1186/s12913-022-08599-7

Pedersen, A., Sieprath, K., & Köhler, M. (2021). Validierung der deutschen Übersetzung des Childbirth Experience Questionnaire (CEQ2). *Diagnostica, 67*(2), 87–97. https://doi.org/10.1026/0012-1924/a000267

Renfrew, M. J., McFadden, A., Bastos, M. H., Campbell, J., Channon, A. A., Cheung, N. F., … Declercq, E. (2014). Midwifery and quality care: Findings from a new evidence-informed framework for maternal and newborn care. *The Lancet, 384*(9948), 1129–1145. https://doi.org/10.1016/S0140-6736(14)60789-3

Salmela-Aro, K., Read, S., Rouhe, H., Halmesmäki, E., Toivanen, R. M., Tokola, M. I., & Saisto, T. (2012). Promoting positive motherhood among nulliparous pregnant women with an intense fear of childbirth: RCT intervention. *Journal of Health Psychology, 17*(4), 520–534. https://doi.org/10.1177/1359105311421050

Sandall, J., Fernandez Turienzo, C., Devane, D., Soltani, H., Gillespie, P., Gates, S., … Rayment-Jones, H. (2024). Midwife continuity of care models versus other models of care for childbearing women. *Cochrane Database of Systematic Reviews, 2024*(4), Article CD004667. https://doi.org/10.1002/14651858.CD004667.pub6

Schmidt, G., Stoll, K., Jäger, B., & Gross, M. M. (2016). German version of the Childbirth Self-Efficacy Inventory and its short form. *Zeitschrift für Geburtshilfe und Neonatologie, 220*(1), 28–34. https://doi.org/10.1055/s-0035-1547296

Schwartz, L., Toohill, J., Creedy, D. K., Baird, K., Gamble, J., & Fenwick, J. (2015). Factors associated with childbirth self-efficacy in Australian childbearing women. *BMC Pregnancy and Childbirth, 15*(1), Article 29. https://doi.org/10.1186/s12884-015-0465-8

Shakarami, A., Mirghafourvand, M., Abdolalipour, S., Jafarabadi, M. A., & Iravani, M. (2021). Comparison of fear, anxiety and self-efficacy of childbirth among primiparous and multiparous women. *BMC Pregnancy and Childbirth, 21*(1), Article 642. https://doi.org/10.1186/s12884-021-04114-8

Shimpuku, Y., Madeni, F. E., Horiuchi, S., Kubota, K., & Leshabari, S. C. (2019). A family-oriented antenatal education program to improve birth preparedness and maternal-infant birth outcomes: A cross sectional evaluation study. *Reproductive Health, 16*, Article 107. https://doi.org/10.1186/s12978-019-0776-8

Shorey, S., Loh, D. N. L., Chan, V., Chua, C., & Choolani, M. A. (2022). Parents' perceptions of antenatal educational programs: A meta-synthesis. *Midwifery, 113*, Article 103432. https://doi.org/10.1016/j.midw.2022.103432

Tabib, M., Humphrey, T., & Forbes-McKay, K. (2026). The influence of antenatal relaxation classes on perinatal psychological well-being and childbirth experiences: A qualitative study. *Journal of Reproductive and Infant Psychology, 44*(1), 27–45. https://doi.org/10.1080/02646838.2024.2369937

Whitworth, K., Donnellan-Fernandez, R., & Fleet, J.-A. (2024). Digital transformation of antenatal education: A descriptive exploratory study of women's experiences of online antenatal education.

Women and Birth, 37(1), 188–196. https://doi.org/10.1016/j.wombi.2023.08.008

Zaman, A., Fadlalmola, H. A., Ibrahem, S. E., Ismail, F. H., Abedelwahed, H. H., Ali, A. M., … Saad, A. M. (2025). The role of antenatal education on maternal self-efficacy, fear of childbirth, and birth outcomes: A systematic review and meta-analysis. *European Journal of Midwifery, 9*, 1–16. https://doi.org/10.18332/ejm/200747

Zamani, P., Ziaie, T., Lakeh, N. M., & Leili, E. K. (2019). The correlation between perceived social support and childbirth experience in pregnant women. *Midwifery, 75*, 146–151. https://doi.org/10.1016/j.midw.2019.05.002