

Impact of Peplau's Communication Therapy on Tokophobia, Stress and Anxiety in Primiparous Pregnant Women: A Quasi-Experimental Study

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ARTICLE INFO	ABSTRACT
Article type: Original article	Background & aim: Tokophobia is a common concern among pregnant women that can negatively affect their mental health and complicate labor. This study evaluated the effect of Peplau's communication therapy in reducing tokophobia, stress, and anxiety in primiparous pregnant women.
Article History: Received: 16-Jun-2025 Accepted: 01-Jun-2026	Methods: A quasi-experimental pre-test/post-test design was used. Sixty nulliparous women with tokophobia from health centers in Ahvaz were assigned to either an experimental group, who underwent eight sessions of communication therapy or a control group, who received routine care only. Data were collected using Hartman's Fear of Childbirth Scale, Cohen's Perceived Stress Scale, and Beck's Anxiety Inventory, and analyzed using Chi-square, t-test, and ANCOVA.
Key words: Communication Therapy Tokophobia Stress Anxiety Primiparous Women	Results: Before the intervention, no significant differences were found between groups in mean scores of tokophobia, stress, or anxiety, indicating homogeneity. After the intervention, the mean tokophobia score decreased to 19.10 ± 7.80 in the experimental group compared to 29.40 ± 6.94 in the control group ($P < 0.001$; 95% CI: 6.48 to 14.11). Stress levels were also significantly reduced in the experimental group (20.40 ± 5.15) compared to the control group (28.16 ± 4.61) ($P < 0.001$; 95% CI: -10.29 to -5.29). Similarly, anxiety scores decreased to 9.13 ± 7.64 in the experimental group, while remaining higher at 16.16 ± 7.55 in the control group ($P < 0.001$; 95% CI: -9.99 to -2.04). Conclusion: Peplau's interpersonal communication therapy effectively reduces tokophobia, stress, and anxiety in primiparous pregnant women. Healthcare providers could consider integrating this structured communication model into routine prenatal care to improve maternal psychological outcomes.

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Introduction

Pregnancy and childbirth are transformative experiences that can profoundly impact women's biological, psychological, and social health (1). During this period, women undergo profound changes, including adapting to the demands of motherhood and facing social and psychological

challenges that may heighten their risk of developing mental health disorders (2). Among these mental health issues, fear of childbirth (tokophobia) has emerged as a significant concern affecting women before and after delivery (3). It often leads to intense anxiety,

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avoidance behaviors, and more requests for elective cesarean deliveries without medical indication (4). It is a common condition, whose prevalence varies across countries (5). More than 80% of women with low-risk pregnancies experience some degree of fear of childbirth, and in 6–10% of cases, this fear leads to serious complications (6-7). Fear and anxiety during pregnancy can contribute to low birth weight, reduced Apgar scores, intrauterine growth restriction, and fetal asphyxia (8). In Iran, it is estimated that about 5–20% of pregnant women suffer from fear of childbirth, with one in five pregnant women experiencing this condition (9). Fear of childbirth has a worldwide prevalence of 14% and is associated with increased maternal stress and post-traumatic stress disorder, creating a vicious cycle that increases the likelihood of experiencing a difficult birth by stimulating the production and secretion of cortisol (10-11).

Pregnancy anxiety is considered a natural coping mechanism for the mother's mental concerns about having a baby, preparing for pregnancy, and the changes that accompany it (12). Studies have shown that the prevalence of anxiety disorders naturally peaks in the first and third trimesters, exceeding 30%, leading to chronic stress and depression in mothers (13). Receiving individualized care during pregnancy and postpartum is important for women with tokophobia (14).

The therapeutic relationship is an individual, meaningful, and purposeful relationship designed to create adaptive responses that require specific skills in some situations (15-16). This relationship can be an effective factor in enhancing the understanding and recognition of patients' needs, problems, and expectations from the process of controlling the situation, as well as engaging them in accepting responsibility for maintaining their health (7). In Peplau's theory, the individual is a developing organism that strives to reduce anxiety caused by his needs, and in this regard, four stages of familiarization, identification, exploitation, and dissolution are proposed to address the problem (17-18). This framework works well with sensory modulation, because one of the main tools in reducing anxiety is the interactive relationship to identify potential triggers and fears while providing non-

invasive interventions (19-20). Alishahi et al. (2017) showed that the correct application of Peplau's interpersonal relationship theory can reduce stress in hemodialysis patients (21). Cacayan et al. (2021) introduced Peplau's theory as a framework for determining a therapeutic approach to managing anxiety in COVID-19 patients (15). However, there is a knowledge gap regarding the application of this theory to the psychological distress experienced by pregnant women.

Given the points outlined above, the fear of childbirth poses numerous problems for pregnant women and newborns. Considering the importance of care during pregnancy, especially for primiparous women, this study investigated whether structured communication therapy can effectively reduce tokophobia, stress, and anxiety among primiparous pregnant women.

Materials and Methods

This study employed a quasi-experimental, post-test-only equivalent control group design to evaluate the effectiveness of Peplau's communication therapy on tokophobia, stress, and anxiety among primiparous pregnant women in Ahvaz, southwestern Iran, during 2020.

Figure 1: Flow diagram of the study

Sixty participants were recruited through convenience sampling and allocated to two groups: an intervention group and a control group, each comprising 30 individuals. Data were collected in both groups before and after the intervention (Figure 1).

The sample size was calculated via power analysis to detect a meaningful reduction in fear of childbirth between intervention and control groups, using the formula reported by Sharifzadeh et al (2018). The estimated required sample size was 60 participants, with 30 women per group, to ensure adequate statistical power (22).

$$\frac{(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2 (S_1^2 + S_2^2)}{d^2} = 27 Z_{1-\frac{\alpha}{2}} = 1.96$$

$$Z_{1-\beta} = 1.28$$

$$S_1 = 25.91$$

$$S_2 = 11.11$$

$$d \leq \bar{X}_1 - \bar{X}_2 = 68.78 - 40.62 = 28.16, d = 20$$

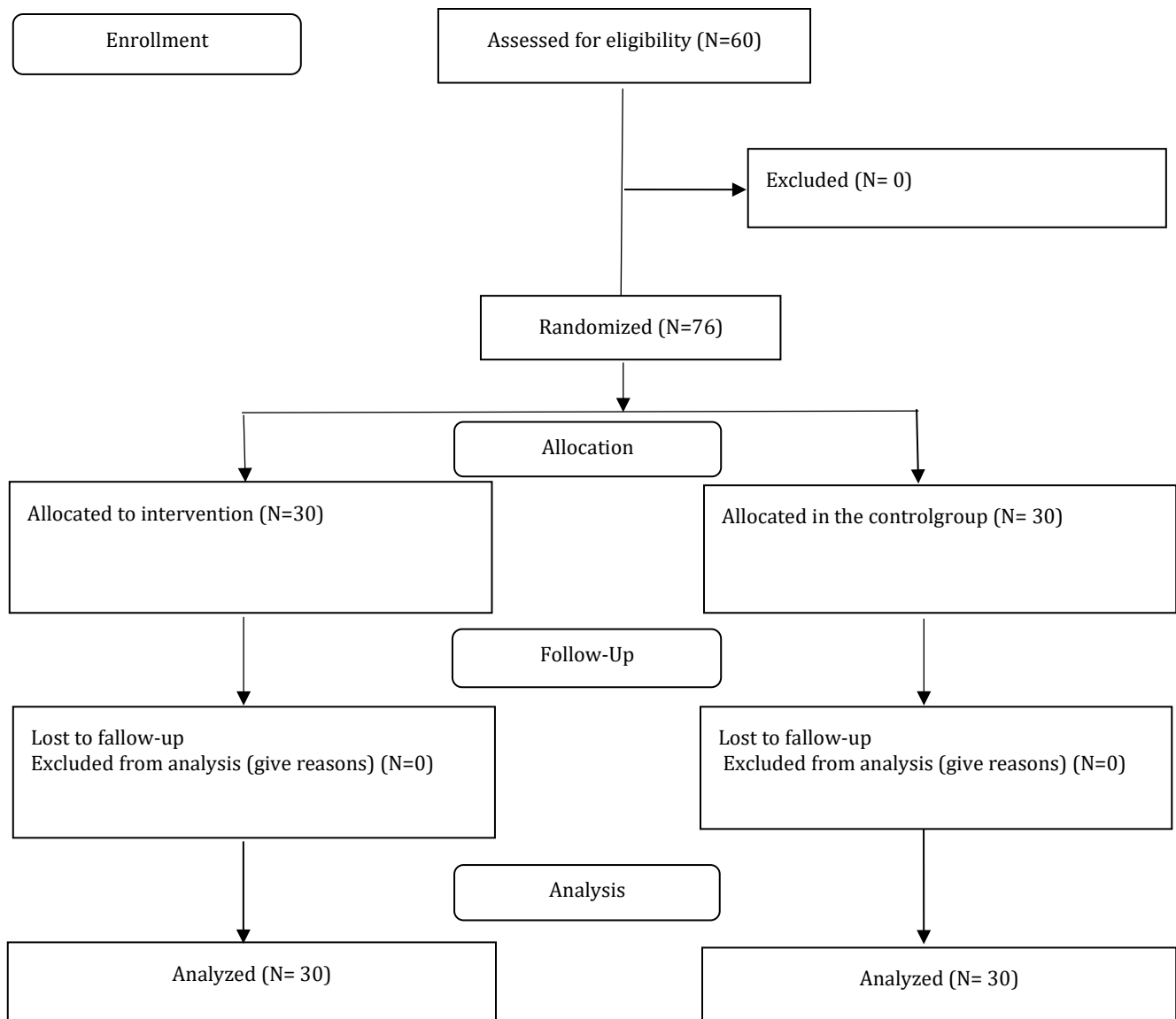


Figure 1. CONSORT Flowchart of the study

The inclusion criteria were as follows: a tokophobia score of 28 or higher based on the Hartmann Childbirth Fear Questionnaire; willingness to participate in the study; primiparous status; third-trimester gestational age; absence of disease or pregnancy-related risks; no restrictions on the choice of delivery method; no fetal risks during pregnancy; and no

severe psychiatric disorders. The exclusion criteria included pregnant mothers who were at high risk circumstances and those with incomplete questionnaires. Three standardized instruments were used to collect data. Participants completed questionnaires before and after the intervention (pretest and posttest) in both experimental and control groups, with strict adherence to ethical standards maintained throughout the research process. The tools

employed in this study include Hartmann's Childbirth Attitude Questionnaire (CAQ), Cohen's Perceived Stress Scale (PSS), and Beck Anxiety Inventory (BAI).

The Childbirth Attitude Questionnaire (CAQ) was developed by Lowe to assess fear of childbirth. It comprises 16 items rated on a four-point Likert scale from 1 (not at all) to 4 (very much). Total scores range from 16 to 64, with higher scores indicating greater fear of childbirth. The CAQ categorizes fear into four levels: low fear (16–27), mild fear (28–39), moderate fear (40–51), and severe fear (52–64). The instrument has demonstrated good internal consistency, with a Cronbach's alpha of 0.83 (23). It has been used in national and international studies. Accordingly, the CAQ was selected because of its cultural and social appropriateness (24–25).

The Perceived Stress Scale (PSS), developed by Cohen et al., is a 14-item instrument designed to assess an individual's perception of stress over the past month. It evaluates thoughts and feelings related to stressful events, coping strategies, and psychological pressure. Each item is rated on a 5-point Likert scale (0 to 4), with higher scores reflecting greater stress (26). The scale includes two subscales: a negative perception subscale (items 1, 2, 3, 4, 11, 12, 14) and a positive perception subscale (items 5, 6, 7, 8, 9, 10, 13), with the latter requiring reversed scoring. The total score ranges from 0 to 56, with higher scores reflecting higher levels of stress. The scale demonstrates good reliability, with Cronbach's alpha coefficients of 0.71 for the positive perception subscale, 0.75 for the negative perception subscale, and 0.84 for the total score. Its construct validity has also been confirmed by experts, supporting its effectiveness as a stress assessment tool (27).

The Beck Anxiety Inventory (BAI) is a 21-item tool developed by Aaron T. Beck and colleagues to evaluate the severity of anxiety symptoms, including mental, physical, and panic-related symptoms. Each item is scored from 0 ("not at all") to 3 ("severe"). The interpretation of scores is as follows: 0–7 indicates no anxiety, 8–15 suggests mild anxiety, 16–25 reflects moderate anxiety, and 26–63 signifies severe anxiety (28).

The intervention was a structured therapeutic communication program developed based on Hildegard Peplau's interpersonal relations theory (1997). The content and sequencing of sessions were systematically designed to operationalize Peplau's four therapeutic phases: orientation, identification, exploitation (working), and resolution (termination) (Figure 2). Each phase incorporated clearly defined nurse roles, theoretical constructs, therapeutic techniques, and expected psychological outcomes (17).

The intervention was delivered by a trained psychiatric nurse with prior experience in therapeutic communication. A structured session guide was developed to ensure fidelity and consistency across participants. Sessions were conducted weekly in small groups at health centers and lasted 30–40 minutes each. In this study, researchers visited Ahvaz health centers for data collection and intervention purposes. The intervention group of pregnant women received communication therapy based on this theory in eight sessions. The intervention took place at these centers, adhering to all prenatal health and COVID-19 protocols.

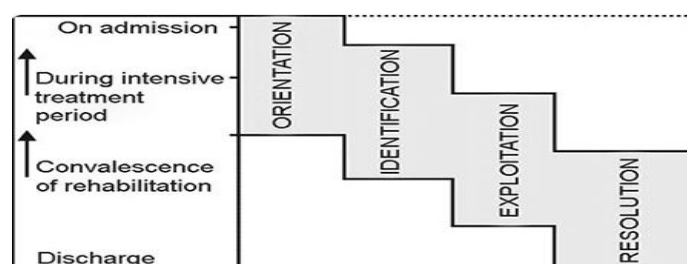


Figure 2. Structures of Hildegard Peplau's theory of Interpersonal Relations

Orientation phase: One 30-minute session focused on clarifying participants' expectations of the care team, identifying their needs, and establishing a sense of security through active listening.

Identification phase: Three 40-minute sessions in which the researcher encouraged participants to discuss their concerns, fears, and questions, thereby exploring their psychological needs.

Exploitation (Working) phase: Three 40-minute sessions in which individualized care plans were developed and implemented,

including interventions to reduce anxiety and tension, with family members involved when appropriate.

Resolution(Termination) phase: One 40-minute session devoted to evaluation, summarizing the communication process, and reflecting on behavioral and emotional changes.

In total, the intervention consisted of eight sessions. Two weeks after completion, participants in the experimental group completed the questionnaires again. It is worth noting that the control group received routine care and did not receive the intervention (Table 1).

Table 1. Phases and times of the therapeutic communication sessions based on Peplau's theory structures

Phase	No. of Sessions	Duration	Main Objectives	Activities
Orientation	1	30 min	Build Rapport, Clarify Expectations, Identify Needs, And Establish A Sense Of Security	Introduce Intervention, Open-Ended Discussion Of Expectations, Initial Needs Assessment, Active Listening, And Validate Feelings
Identification	3	40 min	Explore Concerns, Fears, And Questions; Encourage Open Discussion Of Issues	Guided Discussion On Pregnancy Anxieties, Reflective Listening, Validating Emotions, Identify Emotional Themes
Exploitation	3	40 min	Develop And Implement Individualized Care Plans; Reduce Anxiety And Tension; Involve Family When Appropriate	Teach Relaxation Techniques, Develop Coping Strategies, Role-Play Family Communication, Monitor Response, And Adjust Interventions
Resolution	1	40 min	Evaluate The Program, Summarize The Communication Process, Reflect On Changes, And Determine The Usefulness	Summarize The Intervention Process, Participant Reflection,

Descriptive statistics included frequency distributions, percentages, means, and standard deviations. Additionally, analytical methods included Chi-square, t-test, and analysis of covariance (ANCOVA), which were used to control for occupational status as a covariate. Data analysis was performed using SPSS software, version 25. In this study, a 0.05 level of significance was considered.

Results

In this study, 60 primiparous women completed the intervention and post-tests. The analysis conducted using Chi-square test on variables such as age, education, occupation, abortion history, type of pregnancy, insurance status, and economic status did not reveal significant differences between the experimental and control groups. However, the results indicated that there is a significant difference in occupational status between the two groups, as detailed in Table 2.

Table 2. Frequency and percentage of demographic variables of pregnant women referring to healthcare centers

Variable	Experimental group Frequency (%)	Control group Frequency (%)	χ^2 (df)	P-Value
Age				
20>	3 (10)	4 (13.35)		
20-25	4 (13.3)	6 (20)		
25-30	11 (36.7)	8 (26.6)		
30-35	8 (26.6)	10 (33.3)	1.9(4)	0.753
35<	4 (13.5)	2 (6.6)		
Educational level				
Diploma and below it	16 (53.3)	19 (63.3)		
Upper diploma	14 (46.7)	11 (36.7)	0.61(1)	0.6
Occupational status				
Employed	16 (53.4)	8 (26.6)		
Housewife	14 (46.6)	22 (73.4)	4.44(1)	0.035*
Abortion				
No	6 (20)	11 (36.6)		
Yes	24 (80)	19 (63.4)	2.05(1)	0.152
Type of pregnancy				
Unwanted	23 (76.6)	17 (56.7)		
Wish	7 (23.4)	13 (43.3)	2.7(1)	0.100
Having insurance				
Not	25 (83.4)	21 (70)		
Yes	5 (16.6)	9 (30)	1.49(1)	0.222
The economic status				
Weak	1 (3.3)	2 (6.7)		
Medium	13 (43.3)	10 (33.3)		
Good and higher	16 (53.3)	18 (60)	0.84(2)	0.82

*P<0.05

Table 3 shows the mean and standard deviation of tokophobia in the experimental and control groups before (32.40±8.70) and after

intervention (19.10±7.80), respectively. A t-test indicated a significant decrease in tokophobia within the experimental group (P<0.001).

Table 3. Comparison of the mean and standard deviation of and post- intervention scores of tokophobia, stress, and anxiety in the experimental and control groups

Variable	Groups		Mean difference (Confidence interval 0.95)	Test results
	Experimental (Mean± SD)	Control (Mean± SD)		
Tokophobia				
Before	32.66 ± 8.70	35.73 ± 8.64	3.06 (-1.41 to 7.55)	0.17
After	19.10 ± 7.80	29.40 ± 6.94	-10.3 (6.48 to 14.11)	<0.001
P-Value	<0.001	<0.001		
Stress				
Before	28.83 ± 8.55	28.06 ± 7.19	0.5 (-3.62 to 4.62)	0.7
After	20.40 ± 5.15	28.16 ± 4.61	-7.76 (-10.29 to -5.29)	<0.001
P-Value	<0.001	0.94		
Anxiety				
Before	16.06 ± 11.22	15.63 ± 7.86	2.21 (-2.63 to 7.07)	0.86
After	9.13 ± 7.64	16.16 ± 7.55	-6.01 (-9.99 to -2.04)	<0.001
P-Value	<0.001	0.04		

Additionally, the results show that the mean and standard deviation of tokophobia in the control group decreased significantly from 35.73 ± 8.64 to 29.40 ± 6.94 ($P < 0.001$). The mean stress score for the experimental group after intervention was 20.40 ± 5.15 , whereas the control group exhibited a higher mean score of 28.16 ± 4.60 . The t-test results indicated that the intervention significantly reduced the level of stress in the experimental group compared to the control group ($P < 0.001$). Our results revealed that the mean and standard deviation of anxiety before and after the intervention in the

experimental group were 16.06 ± 11.22 and 9.13 ± 7.64 , respectively. The t-test indicated that the intervention significantly reduced anxiety scores in the experimental group compared to the control group ($P < 0.001$).

Additional analysis for showing the mean and standard deviation of score changes across the three variables included tokophobia, stress, and anxiety, revealed that these changes were 13.56 ± 1.61 , 8.43 ± 5.58 , and 7.70 ± 4.53 , respectively. The t-test indicated these changes were significant ($P < 0.001$) (Table 4).

Table 4. Mean and standard deviation of changes between pre and post-intervention scores of tokophobia, stress, and anxiety in the experimental and control groups

Variables	Experimental (Mean± SD)	Control (Mean± SD)	P-Value
Tokophobia	13.56±1.61	6.33±3.35	<0.001
Stress	8.43±5.58	-0.16±8.47	<0.001
Anxiety	7.70±4.53	-0.53±1.40	<0.001

The ANCOVA results showed that, after controlling for the effect of occupational status through covariance analysis, the differences in tokophobia, stress, and anxiety between experimental and control groups were

statistically significant ($P < 0.001$). Findings revealed that the effect sizes for tokophobia, stress, and anxiety were 0.761, 0.415, and 0.697, respectively (Table 5).

Table 5. ANCOVA results of tokophobia, stress, and anxiety after controlling for the effects of pre-intervention difference of occupational status between the experimental and control groups

Variable	Mean Square	F	P-Value	Effect Size
Tokophobia before intervention	2889.708	666.521	<0.001	
Group (E&C)	771.706	177.997	<0.001*	0.761
Occupation status	11.752	2.711	<0.105	
Stress before intervention	306.481	18.399	<0.001	
Group (E&C)	662.504	39.773	<0.001*	0.415
Occupation status	187.852	11.277	<0.001	
Anxiety before intervention	2706.828	410.161	<0.001	
Group (E&C)	805.218	122.013	<0.001*	0.697
Occupation status	0.421	0.064	0.802	

* Indicates significant difference between groups ($p < 0.05$)

Discussion

This study demonstrated that a structured therapeutic communication intervention grounded in Peplau's interpersonal relations model significantly reduced tokophobia, perceived stress, and anxiety in primiparous pregnant women. Rather than merely confirming statistical significance, these outcomes can be understood through the theoretical architecture of Peplau's framework and its neurobehavioral

implications. Theoretically, Peplau conceptualizes anxiety as a response to unmet needs and interpersonal uncertainty, proposing that healing occurs through a phased, purposeful nurse-patient relationship (17). During the orientation phase, establishing psychological safety and clarifying expectations helped reduce anticipatory distress. The identification phase allowed participants to articulate and normalize childbirth-related fears, thereby decreasing cognitive avoidance. During the exploitation

phase, individualized coping strategies, relaxation techniques, and family involvement were actively practiced, enhancing maternal self-efficacy and emotional regulation (29). Finally, the resolution phase consolidated behavioral gains. Practically, this structured, phase-guided engagement likely modulated the hypothalamic-pituitary-adrenal (HPA) axis response, interrupting the fear-tension-pain cycle and replacing catastrophic cognitions with actionable coping skills (30). Unlike generic antenatal education that primarily delivers didactic information, Peplau-based therapy co-constructs meaning, validates emotions, and builds relational trust, which are established mediators of psychological resilience during pregnancy (15).

The magnitude of change observed in this study was substantial, with effect size (η^2) of 0.761 for tokophobia, 0.697 for anxiety, and 0.415 for stress. These effect sizes notably exceed the small-to-moderate effects typically reported in standard psychoeducational or information-based antenatal programs (31). While routine midwifery counseling or group-based childbirth classes often yield moderate reductions in fear and anxiety, our findings align more closely with relationship-focused or cognitive-behavioral interventions, which report larger effects (22,31). This suggests that the therapeutic alliance, structured phase progression, and personalized care planning inherent in Peplau's model amplify psychological outcomes beyond mere knowledge transfer. The intervention's fidelity to theoretical constructs, combined with consistent facilitator training and weekly delivery, likely contributed to this robust clinical impact.

The findings of this study are consistent with previous research demonstrating the effectiveness of communication-based and educational interventions. For instance, Farajzadeh et al. (2018) reported that antenatal education reduces fear of childbirth by improving knowledge and preparedness (32). Similarly, guidelines emphasize the importance of respectful communication and emotional support in improving maternal mental health outcomes (33). In line with the present findings, studies by Khanzadeh et al. (2017), Alishahi et al. (2017), and Maghsoudi et al. (2014) have

shown that therapeutic communication significantly reduces anxiety levels in clinical populations (19,21,34).

Fear of childbirth is a common complication in pregnant women (35). Tokophobia in nulliparous women is influenced by factors such as anxiety, socio-economic status, inexperience with pregnancy, and fear of labor pain. Effective communication plays a key role in reducing fear and anxiety by providing accurate information, reassurance, and emotional support. Clear, empathetic communication with healthcare providers can address concerns, alleviate misconceptions, and reduce the fear of complications, ultimately improving the childbirth experience and reducing tokophobia (35,36). It seems that by observing different stages of communication in Peplau's, midwives can build mutual trust between themselves and pregnant women and play a positive role in reducing tokophobia and other problems of pregnant women (37).

According to the results of the present study, the level of anxiety in pregnant women decreased after the intervention in the experimental group. Following the intervention, the anxiety levels of pregnant women reached their lowest point, indicating the positive effect of using Peplau's communication model. Andron et al. investigated the effect of a midwifery counseling program on prenatal anxiety in nulliparous women in Mashhad and found a statistically significant difference between the intervention and control groups. Accordingly, the midwife counseling program during pregnancy reduces anxiety related to pregnancy in nulliparous women (38).

However, not all studies have reported consistent results. For example, some systematic reviews, such as that of Shabakhti et al. (2020), indicate that educational interventions alone may not be sufficient to reduce severe tokophobia, particularly when deeper psychological factors are involved (11). Similarly, O'Connell et al. reported that fear of childbirth is multifactorial and may persist despite routine interventions. These inconsistencies suggest that interventions grounded in interpersonal and therapeutic frameworks, such as Peplau's model, may be more effective than purely informational approaches (14).

Regarding effect sizes, the magnitude of change observed in the present study appears relatively large, particularly for tokophobia and anxiety. Previous intervention studies in this field have often reported small to moderate effect sizes, especially when interventions were brief or non-interactive. The larger effect sizes observed in this study may be attributed to the structured, multi-session design and the emphasis on therapeutic interaction, which likely enhanced participant engagement and emotional processing.

An important finding of this study was the significant reduction in tokophobia observed in the control group. Several explanations may account for this result. First, routine prenatal care itself may provide reassurance and information, contributing to a natural decline in fear over time. Second, repeated measurement may have increased participants' awareness of their emotional state (measurement effect). Third, external factors such as social support and adaptation to pregnancy may also have influenced outcomes. Similar reductions in control groups have been reported in previous studies, suggesting that psychological adaptation during pregnancy is a dynamic process (14).

Despite these significant findings, several methodological limitations should be considered. The use of convenience sampling may introduce selection bias and limit the generalizability of the results. Additionally, the lack of blinding may have led to performance bias, and the reliance on self-reported questionnaires increases the likelihood of response and social desirability bias. These issues are widely discussed in clinical research methodology literature and should be addressed in future randomized controlled trials.

Finally, the findings of this study showed that applying Peplau's interpersonal communication model significantly reduced tokophobia, stress, and anxiety in nulliparous pregnant women, with large effect sizes for tokophobia, anxiety, and stress, respectively. These results indicate that the intervention had a substantial clinical impact beyond statistical significance. By providing education, reassurance, and emotional support while building trust, nurses can effectively alleviate fear and anxiety, improve maternal psychological well-being, and enhance the childbirth experience. These findings align with

previous studies that demonstrate the positive effects of structured therapeutic communication on prenatal mental health (34,39).

Conclusion

The findings of this study suggest that a therapeutic communication model grounded in Peplau's theory may significantly reduce tokophobia, anxiety, and stress among primiparous pregnant women. While the results are promising, the quasi-experimental design and the use of convenience sampling necessitate caution in generalizing the findings to broader populations. To enhance maternal well-being, it is recommended to consider targeted educational interventions for pregnant women and their caregivers, focusing on the adoption of structured therapeutic communication. Such approaches have shown potential in fostering emotional support, improving understanding, and facilitating better coping strategies during the third trimester. Integrating these communication strategies into prenatal care programs could contribute to improved maternal mental health and greater confidence during childbirth. Furthermore, providing training to midwives and nurses in the effective use of Peplau's model is recommended to ensure more comprehensive psychological support for expectant mothers within the healthcare system.

Declarations

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Conflicts of interest

The authors declared no conflicts of interest.

Ethical approval

Participants and their families were fully informed about the objectives and procedures of the study, and written informed consent was obtained from all individuals prior to

participation. Pregnant women were assured that all personal information would remain strictly confidential and would be used solely for research purposes. Participation was voluntary, and they were informed of their right to withdraw from the study at any time without any impact on their routine care.

Code of Ethics

This study was approved by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (AJUMS), Ahvaz, Iran, with the ethical code: IR.AJUMS.REC.1399.680.

Use of Artificial Intelligence

Artificial Intelligence, including Grammarly and Quill Bot, was used by the authors to assist in editing sentence structure and rewriting certain parts of the manuscript, without changing the substance of the data or the results of the analysis.

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Authors' contributions

YDGh, KZ, HKS, AS, and MH were involved in designing the study. YDGh collected the data. MH analyzed the data. KZ and HKS were involved in data interpretation. YDGh, KZ and AS prepared the initial draft of the manuscript. KZ was responsible for writing and finalizing the manuscript. All authors read and approved the final version of the manuscript.

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