

RESEARCH NOTE

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The association between maternal-fetal attachment and adherence to health behaviors among pregnant women

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Abstract

Introduction The attachment a mother feels for her fetus intensifies her duty to care for it, leading to a heightened desire to engage in behaviors that promote health. This research explored the association between maternal-fetal attachment (MFA) and adherence to health-related behaviors among pregnant women.

Methods This cross-sectional study focused on 220 pregnant women in Jahrom City, and was conducted using a multi-stage random sampling strategy. The data were collected using the Maternal-Fetal Attachment Scale paired with a questionnaire that addressed health behaviors relevant to pregnancy. The data were analyzed using SPSS18 software, employing linear regression and the Pearson correlation test. A p-value of less than 0.05 was deemed significant.

Results The mean age of participants was 28.06 ± 5.12 years. The adherence to health behaviors in pregnant women yielded a mean score of 174.51 ± 20.20 . Pearson's correlation test revealed a significant statistical association between MFA and adherence to health behaviors ($r = 0.54, p < 0.001$). The linear regression analysis showed that the dimensions of interaction with the fetus ($\beta = 0.19$) and the act of surrendering to the fetus ($\beta = 0.27$) could explain 35% of the variance in adherence to health behaviors ($F = 14.12, R^2 = 0.35, p < 0.001$).

Conclusion This study highlights a significant association between MFA and adherence to health behaviors throughout pregnancy. Supportive measures may strengthen MFA, promoting self-care practices and behaviors, ultimately resulting in improved health for both the mother and her fetus.

Keywords Maternal-fetus attachment, Health behaviors, Pregnancy

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Introduction

Expectant mothers, regardless of their cultural or demographic variations, commonly exhibit an innate desire to establish a bond with their unborn child [1]. Referred to as maternal-fetal attachment (MFA), this unique phenomenon illustrates the emotional ties a mother forms with her fetus, which are pivotal in her adaptation to the maternal role during pregnancy [2].

MFA can be observed through various behaviors, such as talking to the fetus, caressing the abdomen, and recognizing the fetus's position. These behaviors are integral to the mother's acceptance of her identity, the positive outcome of the pregnancy, and the child's growth and development [3, 4]. Various demographic and psychological factors significantly influence MFA. These factors encompass ethnicity, maternal age, educational background of the mother, whether the pregnancy was planned, the sex of the fetus, assessments of fetal health [5], maternal religious beliefs, stress tolerance, the number of previous births [6], and the availability of social support [7].

It should be emphasized that pregnancy, associated with lifestyle changes, represents a critical period during which the adoption of healthy behaviors becomes particularly significant [8]. The behaviors consist of various measures, such as engaging in physical activities, following a healthy diet, controlling substance abuse, participating in regular clinical evaluations, managing stress, and maintaining effective communication with family members [9–11].

Evidence suggests that diminished MFA may correlate with poor adherence to health-related behaviors throughout pregnancy [12]. According to the study by Magee et al., pregnant women who smoke regularly are associated with a decrease in the adoption of health-related behaviors throughout their pregnancy and exhibit a lower level of dependence on their fetus [13]. Moreover, the study by Gioia et al. illustrates that mothers with lower levels of fetal attachment are likely to exhibit less favorable health behaviors and higher instances of anxiety and depression [14].

The current body of studies in Iran has predominantly examined a narrow range of factors, notably demographic variables, concerning MFA. Furthermore, there is a notable gap in the literature regarding the relationship between MFA and the adherence of pregnant women to various health-related behaviors such as healthy diet and nutritional supplements, getting enough rest during pregnancy, medication use management, seeking health information, getting necessary checkups and adherence to health recommendations. Therefore, this study aimed to analyze the association between the MFA and adherence to health behaviors during pregnancy among pregnant women in Jahrom City, southern Iran.

Methods

This cross-sectional study was conducted in 2022 in Jahrom, the second most populous city in Fars province, southern Iran. This Study utilized a multi-stage sampling approach. The first step involved identifying eight geographical areas in the town as distinct clusters. In the subsequent stage, four of these clusters were selected at random. Ultimately, the sampling was carried out at the comprehensive health service centers located in each cluster, with the sample size reflecting the proportion of registered pregnant women in those areas, achieved through a simple random sampling technique.

A pilot study was carried out to estimate the sample size required. The findings, which incorporated a standard deviation of 0.37, a confidence interval of 0.95, and an accuracy of 0.05, suggested that a sample size of 200 individuals would suffice. To increase the study's power, the total number of participants was raised to 220 pregnant mothers. Inclusion criteria were established to require a definitive diagnosis of pregnancy, literacy, Iranian nationality, an age range of 18 to 35 years, and a gestational age of 20 to 40 weeks, which is typically associated with the experience of fetal movement. Both primiparous and multiparous women are eligible to participate in the study. The exclusion criteria involve restrictions on physical activity, the necessity for a specific dietary approach, the presence of underlying medical conditions (including diabetes, high blood pressure, cardiovascular diseases, and severe mental health disorders), classification as a high-risk pregnancy, the need for total rest, cases of unplanned pregnancy and women conceived with assisted reproductive technique.

This study utilized two distinct questionnaires for data collection. The Persian standardized version of the Maternal Fetal Attachment Scale (MFAS) assessed the attachment between mothers and their fetuses [5]. The MFAS is composed of 24 items rated on a Likert scale from one to five points, with one indicating "never" and five indicating "almost always." The scoring framework allows for a minimum of 24 and a maximum of 120, indicating that elevated scores are associated with a more robust attachment level. MFAS is segmented into five subscales, including the differentiation of the self from the fetus, the interaction with the fetus, the attribution of characteristics to the fetus, the act of surrendering to the fetus, and the assumption of a role. The second instrument used in this research was a questionnaire that investigated health behaviors during pregnancy. This questionnaire is divided into two main sections. The first section features questions on demographic variables and general inquiries about the pregnancy. The following section contains 45 questions about mothers' health behaviors during pregnancy. Each question is answered using a 5-point Likert scale, where the responses range

from never (1 point) to always (5 points). Thus, the overall score for health behaviors can be calculated to lie between 45 and 225. This questionnaire has been previously validated and applied in a research study in Iran [15]. Before the questionnaire was administered, the researcher took the time to explain the study's objectives to the participants and secured their informed consent. Participants were also informed that their information would be kept anonymous and confidential.

Data were analyzed using SPSS Statistics for Windows, version 18.0 (SPSS Inc., Chicago, Ill., USA). Descriptive statistics (Mean \pm SD) were employed to characterize demographic variables and to illustrate the results of the questionnaires. The average scores of MFA and adherence to health behaviors were evaluated based on different demographic variables, employing ANOVA and independent sample t-test. The association between MFA and adherence to health behaviors was assessed by Pearson's correlation test. Moreover, the study applied linear regression analysis to explore the predictors associated with adherence to health behaviors among pregnant women.

Results

Most individuals involved in the study, accounting for 45.5%, were aged between 30 and 34. The data showed that 13.1% had not attained a diploma, 35.5% had achieved a diploma, and 51.4% had completed their education at a university. The data indicates that 76.8% of women were homemakers, while 17.3% held positions as employees, and 5.9% operated as self-employed individuals. The average number of children reported by participants was 1.76 (\pm 0.89), and they had an average of 2.12 pregnancies (\pm 1.11). A total of 26.4% of the participants acknowledged a past abortion, while 5% revealed a history of stillbirth, and 7.7% indicated they had experienced an unwanted pregnancy.

Results from the ANOVA test indicated a statistically significant difference in the adherence to health behaviors of pregnant women, categorized by various age groups ($p=0.04$), the number of children ($p=0.009$), and the number of pregnancies ($p=0.008$). Moreover, the findings of ANOVA revealed that MFA exhibited a statistically significant variation based on the number of children ($p=0.01$) and the number of pregnancies ($p=0.01$). According to the independent t-test, there is a significant increase in MFA among women who do not have a history of stillbirth, reflected in a p-value of 0.02 (Table 1).

Table 1 Average scores of MFA and adherence to health behaviors according to the demographic characteristics

Variable	N (%)	Maternal-fetal attachment		Adherence to health behaviors		
		Mean \pm SD	P-value	Mean \pm SD	P-value	
Age categories	<20	21 (9.5)	52.42 \pm 12.76	0.1	179.33 \pm 23.27	0.04*
	20-24	41 (18.6)	48.63 \pm 19.85		181.26 \pm 19.56	
	25-29	58 (26.4)	51.65 \pm 12.89		172.91 \pm 20.06	
	30-34	100 (45.5)	54.45 \pm 13.69		171.66 \pm 19.41	
Educational Level	Under diploma	29 (13.1)	53.17 \pm 13.33	0.3	172.58 \pm 23.09	0.4
	Diploma	78 (35.5)	54 \pm 14.96		172.93 \pm 22.16	
	University	113 (51.4)	51.16 \pm 11.36		176.09 \pm 17.94	
Occupation	Housewife	169 (76.8)	51.73 \pm 12.72	0.3	176.17 \pm 19.81	0.05
	Employee	38 (17.3)	55.18 \pm 13.51		170.13 \pm 19.90	
	Self-employment	13 (5.9)	53.53 \pm 15.08		165.76 \pm 23.96	
Number of children	0	108 (49.1)	50.32 \pm 13.51	0.01*	177.81 \pm 19.50	0.009**
	1	67 (30.5)	53.92 \pm 12.19		171.40 \pm 20.12	
	2	34 (15.5)	52.88 \pm 11.20		175.29 \pm 18.60	
	3 and more	11 (5)	62.72 \pm 13.24		158.63 \pm 24.44	
Number of pregnancies	1	82 (37.3)	49.31 \pm 12.46	0.01*	179.54 \pm 18.71	0.008**
	2	63 (28.6)	53.31 \pm 14.76		173.60 \pm 21.01	
	3 and more	75 (34.1)	55.10 \pm 11.36		169.77 \pm 20.09	
Abortion	Yes	58 (26.4)	54.32 \pm 12.61	0.1	171.12 \pm 18.46	0.2
	No	162 (73.6)	51.75 \pm 13.11		175.72 \pm 20.71	
Stillbirth	Yes	11 (5)	44.90 \pm 9.45	0.02*	168.81 \pm 20.47	0.3
	No	209 (95)	52.83 \pm 13.04		174.81 \pm 20.19	
Economic status	Good	67 (30.5)	51.95 \pm 12.94	0.9	177.67 \pm 22.53	0.2
	Moderate	128 (58.2)	52.55 \pm 13.46		173.67 \pm 18.92	
	Bad	25 (11.3)	53.12 \pm 10.83		170.36 \pm 20.46	

* Significant at 0.05, ** Significant at 0.01

Table 2 Mean scores of dimensions of MFA and the adherence to health behaviors

Variable	Mean \pm SD	Minimum	Maximum
Interaction with the fetus	8.35 \pm 2.53	4	15
Differentiation of the self from the fetus	11.01 \pm 3.52	5	21
Assumption of a role	8.37 \pm 2.86	4	16
Attribution of characteristics to the fetus	14.06 \pm 4.03	6	28
Act of surrendering to the fetus	10.62 \pm 02.78	5	18
Total score of MFA	52.43 \pm 13.01	24	85
Nutrition	58.44 \pm 7.59	39	75
Physical activity and rest	16.52 \pm 3.23	9	25
Stress management	19.46 \pm 3.51	11	25
Medication management	12.95 \pm 2.82	4	15
Health information seeking	6.57 \pm 1.21	3	10
Performing necessary prenatal examinations	30.04 \pm 4.94	7	35
Following health recommendations	30.50 \pm 5.62	8	40
Total score of adherences to health behaviors	174.51 \pm 20.20	122	211

Table 3 Association between dimensions of MFA and adherence to health behaviors

Variable	Interaction with the fetus	Differentiation of the self from the fetus	Assumption of a role	Attribution of characteristics to the fetus	Act of surrendering to the fetus	Total score of MFA
Nutrition	$r=0.47$ $p<0.001^{**}$	$r=0.40$ $p<0.001^{**}$	$r=0.42$ $p<0.001^{**}$	$r=0.34$ $p<0.001^{**}$	$r=0.49$ $p<0.001^{**}$	$r=0.50$ $p<0.001^{**}$
Physical activity and rest	$r=0.06$ $p=0.32$	$r=0.25$ $p<0.001^{**}$	$r=0.05$ $p=0.44$	$r=0.15$ $p=0.02^*$	$r=0.05$ $p=0.44$	$r=0.15$ $p=0.02^*$
Stress management	$r=0.26$ $p<0.001^{**}$	$r=0.33$ $p<0.001^{**}$	$r=0.32$ $p<0.001^{**}$	$r=0.30$ $p<0.001^{**}$	$r=0.30$ $p<0.001^{**}$	$r=0.37$ $p<0.001^{**}$
Medication management	$r=0.29$ $p<0.001^{**}$	$r=0.09$ $p=0.18$	$r=0.28$ $p<0.001^{**}$	$r=0.14$ $p=0.03^*$	$r=0.32$ $p<0.001^{**}$	$r=0.26$ $p<0.001^{**}$
Health information seeking	$r=0.01$ $p=0.83$	$r=0.02$ $p=0.73$	$r=0.04$ $p=0.52$	$r=0.01$ $p=0.82$	$r=0.07$ $p=0.24$	$r=0.01$ $p=0.78$
Performing necessary prenatal examinations	$r=0.37$ $p<0.001^{**}$	$r=0.31$ $p<0.001^{**}$	$r=0.37$ $p<0.001^{**}$	$r=0.24$ $p<0.001^{**}$	$r=0.44$ $p<0.001^{**}$	$r=0.41$ $p<0.001^{**}$
Following health recommendations	$r=0.39$ $p<0.001^{**}$	$r=0.40$ $p<0.001^{**}$	$r=0.40$ $p<0.001^{**}$	$r=0.34$ $p<0.001^{**}$	$r=0.38$ $p<0.001^{**}$	$r=0.46$ $p<0.001^{**}$
Total score of adherences to health behaviors	$r=0.48$ $p<0.001^{**}$	$r=0.45$ $p<0.001^{**}$	$r=0.47$ $p<0.001^{**}$	$r=0.38$ $p<0.001^{**}$	$r=0.51$ $p<0.001^{**}$	$r=0.54$ $p<0.001^{**}$

* Significant at 0.05, ** Significant at 0.01

Table 2 outlines mean scores associated with the dimensions of MFA and the adherence to health behaviors among pregnant women in Jahrom City. The mean total score for MFA and adherence to health behaviors among pregnant women in Jahrom city was recorded at 52.43 \pm 13.01 and 174.51 \pm 20.20, respectively.

The correlation between the dimensions of MFA and the dimensions of adherence to health behaviors in pregnant women of Jahrom City is shown in Table 3. The findings of Pearson's correlation test reveal a significant correlation between MFA and adherence to health behaviors ($p<0.001$, $r=0.54$). The various aspects of adherence to health behaviors, including nutrition, stress management, performing necessary prenatal examinations, and following health recommendations, exhibited a positive and significant correlation with all dimensions of MFA

($P<0.001$). Additionally, the results indicated no statistically significant relationship between health information seeking and any of the dimensions of MFA ($p>0.05$).

The findings of the linear regression analysis aimed at identifying predictors of adherence to health behaviors are presented in Table 4. The data presented in this table indicates that the interaction with the fetus and the act of surrendering to the fetus may account for 35% of the variability in adherence to health behaviors among pregnant women.

Discussion

Developing a relationship between the mother and her fetus during gestation is significant in fostering health behaviors, promoting self-care, and ensuring consistent medical follow-up, contributing to the overall health of

Table 4 Predictors of adherence to health behaviors in pregnant women

Model		β	SE	B	P-value
1	Constant	189.79	9.17		
	Age	0.32	0.35	0.07	0.35
	Number of pregnancies	3.12	2.15	0.02	0.14
	Number of children	0.52	2.71	0.17	0.84
2	Age	0.28	0.3	0.06	0.34
	Number of pregnancies	1.9	1.82	0.1	0.29
	Number of children	1.31	2.28	0.05	0.56
	Interaction with the fetus	1.53	0.63	0.19	0.01*
	Differentiation of the self from the fetus	0.88	0.53	0.15	0.09
	Assumption of a role	0.53	0.61	0.07	0.37
	Attribution of characteristics to the fetus	0.1	0.43	0.02	0.81
	Act of surrendering to the fetus	1.94	0.56	0.26	0.001*

* Significant at 0.05

both the mother and the fetus. The present research analyzed the relationship between MFA and adherence to health behaviors within a sample of pregnant women in Iran.

The results of this research highlight a significant positive correlation between MFA and adherence to health behaviors in pregnant women. Furthermore, two specific dimensions of MFA, interaction with the fetus and act of surrendering to the fetus, account for 35% of the variance observed in adherence to these health behaviors. In this respect, a body of scientific evidence suggests that MFA is associated with increased self-care practices and health-oriented behaviors during pregnancy. The study by Alhusen et al. focusing on pregnant African-American women demonstrated that various health measures, including sufficient sleep, lower caffeine intake, protected sexual practices, advice from healthcare providers or social networks, relaxation, and reduced substance use, were significantly associated with MFA and neonatal outcomes [16]. The investigation by Eltomy et al. on pregnant women admitted to Alexandria Hospital demonstrated a significant link between the MFA score and general self-care activities. These activities comprised nutrition, safety measures, risk avoidance, and the seeking of health care and information [17].

In alignment with the findings of this study, the results of a meta-analysis indicate that MFA is a significant predictor of prenatal health behaviors [18]. A study by Jeon et al. focusing on pregnant women in Korea indicated that the degree of MFA, as well as the social dynamics of the pregnancy experience, elucidates 43% of the variance in health-promoting behaviors that change during pregnancy [19]. The positive impact of healthy behaviors on the health of pregnant women and the development of their fetuses underscores the necessity of considering relevant factors in educational interventions aimed at this population. To facilitate the enhancement of maternal-fetal attachment (MFA), it is vital to employ a

combination of interventions that include both counseling and training sessions. These sessions should focus on various elements, such as adapting to the changes brought about by pregnancy, providing nutritional guidance, identifying danger signs, familiarizing mothers with attachment behaviors, engaging in belly touching, and interpreting the fetal condition [20, 21].

The results of this research suggest that health behavior adherence among pregnant women is associated with specific demographic factors, including a younger maternal age, a lower number of children, and a reduced number of previous pregnancies. Consistent with the outcomes of the present study, the research conducted by Boybay et al. in Turkey indicates that pregnant women aged 20–25, those who are primiparous or have no more than one child, exhibit elevated scores in health-promoting behaviors during pregnancy compared to their counterparts [22]. In contrast to the findings of this study, there are indications from other research that younger mothers are less likely to adopt health-related behaviors. Such differences may stem from geographic, cultural, and demographic variations among the populations studied [23]. Cannella et al. have found that various demographic characteristics, including employment, income, educational level, and gender equality, along with psychosocial factors such as depression, stress, and social support, can influence the extent to which pregnant women engage in health-related behaviors [18]. According to Urizar et al., the involvement of a substantial proportion of women in unhealthy health practices during pregnancy underscores the urgent requirement for preventive interventions. It is advised that these interventions consider both the individual characteristics of pregnant women and the broader systemic factors, allowing women to better cope with the challenges of pregnancy and motherhood [23]. Consequently, it is essential to determine the demographic factors that may contribute to enhancing health

behaviors throughout pregnancy and their subsequent outcomes.

The study's results indicate that there is a significant inverse relationship between the level of a mother's attachment to her fetus and both the number of children she raises and the number of pregnancies she has experienced. Findings from the study by Chen et al. suggest that women who achieve their first pregnancy after infertility treatment report higher levels of attachment to both the fetus and the newborn [24]. In the current research, it was observed that women without a history of stillbirth exhibited significantly higher levels of MFA. This observation parallels the findings of Mehran et al., who reported that women with a prior stillbirth demonstrated a significantly lower score in the dimension of differentiation of the self from the fetus [25]. Several studies have pointed to additional variables that are associated with maternal-fetal attachment (MFA) in pregnant women. These variables include maternal educational level, participation in antenatal education [24], support from partners [26] and paternal attachment [27], cultural attitudes towards childbirth, awareness of fetal development, social support [28], race, advanced maternal age, higher education, gestational age, planned nature of pregnancy, fetal sex, and fetal health assessments [5]. In addition, there is evidence that show parents who use infertility treatments have a high level of attachment to their babies [29].

Limitations of the study

The main limitation of the present study lies in its cross-sectional nature. This approach inhibits the assessment of causal relationships between the variables, thus necessitating the implementation of longitudinal studies for more comprehensive insights. Furthermore, the reliance on self-report questionnaires represents an additional limitation of the study, which could have impacted the reliability of the responses. Also women who became pregnant through assisted reproductive techniques were not included in this study. This can be investigated in future studies.

Conclusions

This study highlights a significant association between MFA and adherence to health behaviors throughout pregnancy. Also, some demographic and prenatal variables were associated with them. These findings can assist healthcare providers in tailoring their efforts to promote maternal and child healthcare. Different subgroups of pregnant women can be considered by healthcare professionals in terms of education about the changes caused by pregnancy and how to adapt to them. Identifying the individual and environmental barriers that reduce MFA in women and negatively impact their adherence

to health measures is crucial. Supportive measures presented by healthcare providers and families of pregnant women may strengthen MFA, promoting self-care practices and behaviors, ultimately resulting in improved health for both the mother and her fetus.

Abbreviations

MFA Maternal-fetal Attachment

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Author contributions

TR proposed the study. RS and SY collected the data and YS performed the statistical analysis. TR prepared the first draft of the manuscript and the authors read, revised and approved the final manuscript.

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Data availability

The data sets used and/or analyzed during the current study are not publicly available due to confidentiality of data and subsequent research, but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval for this research has been secured from the ethics committee of Jahrom University of Medical Sciences, designated by the code IR.JUMS.REC.1401.046. A written informed consent was obtained from all participants. The study was performed in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable: individual information has not been published.

Competing interests

The authors declare no competing interests.

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References

1. Lingeswaran A, Bindu H. Validation of Tamil Version of Cranley's 24-Item maternal-fetal attachment scale in Indian pregnant women. *J Obstet Gynecol India*. 2012;62(6):630–4.
2. Ustunsoz A, Guvenc G, Akyuz A, Ofiaz F. Comparison of maternal-and paternal-fetal attachment in Turkish couples. *Midwifery*. 2010;26(2):1–9.
3. Maddahi MS, Dolatian M, Khoramabadi M, Talebi A. Correlation of maternal-fetal attachment and health practices during pregnancy with neonatal outcomes. *Electron Physician*. 2016;8(7):2639–44.
4. Foley S, Hughes C. Great expectations? Do mothers' and fathers' prenatal thoughts and feelings about the infant predict parent-infant interaction quality? A meta-analytic review. *Dev Rev*. 2018;48:40–54.
5. Jamshidimanesh M, Astaraki L, Behboodi Moghadam Z, Taghizadeh Z, Haghani H. Maternal-fetal attachment and its Associated factors. *J Hayat*. 2013;18(5):33–45.
6. Yoon H, Choi H. Factors influencing maternal-fetal attachment in pregnant women during the COVID-19 pandemic: a cross-sectional study. *Korean J Women Health Nurs*. 2023;29(1):55–65.
7. da Rosa KM, Scholl CC, Ferreira LA, Trettim JP, da Cunha GK, Rubin BB, et al. Maternal-fetal attachment and perceived parental bonds of pregnant women. *Early Hum Dev*. 2021;154:105310.
8. Rockliffe L, Peters S, Heazell AEP, Smith DM. Factors influencing health behaviour change during pregnancy: a systematic review and meta-synthesis. *Health Psychol Rev*. 2021;15(4):613–32.

9. Nguyen LD, Nguyen LH, Ninh LT, Nguyen HTT, Nguyen AD, Vu LG, et al. Women's holistic self-care behaviors during pregnancy and associations with psychological well-being: implications for maternal care facilities. *BMC Pregnancy Childbirth*. 2022;22(1):631.
10. Aşci Ö, Rathfisch G. Effect of lifestyle interventions of pregnant women on their dietary habits, lifestyle behaviors, and weight gain: a randomized controlled trial. *J Health Popul Nutr*. 2016;35:7.
11. Fathnezhad-Kazemi A, Hajian S. Factors influencing the adoption of health promoting behaviors in overweight pregnant women: a qualitative study. *BMC Pregnancy Childbirth*. 2019;19(1):43.
12. Lindgren K. Relationships among maternal-fetal attachment, prenatal depression, and health practices in pregnancy. *Res Nurs Health*. 2001;24(3):203–17.
13. Magee SR, Bublitz MH, Orazine C, Brush B, Salisbury A, Niaura R, et al. The relationship between maternal-fetal attachment and cigarette smoking over pregnancy. *Matern Child Health J*. 2014;18(4):1017–22.
14. Gioia MC, Cerasa A, Muggeo VMR, Tonin P, Cajiao J, Aloia A, et al. The relationship between maternal-fetus attachment and perceived parental bonds in pregnant women: considering a possible mediating role of psychological distress. *Front Psychol*. 2022;13:1095030.
15. Rahimi T, Abdollahi H, Mehralizadeh A, Seyedi F. Predictors of health-promoting behaviors in pregnant women referred to Jiroft Ayatollah Kashani Hospital in 2019. *J Torbat Heydariyeh Univ Med Sci*. 2020;8(2):36–46.
16. Alhusen JL, Gross D, Hayat MJ, Woods AB, Sharps PW. The influence of maternal-fetal attachment and health practices on neonatal outcomes in low-income, urban women. *Res Nurs Health*. 2012;35(2):112–20.
17. Eltomy EH, Rasha ME, Naglaa FF. Relationship between maternal fetal attachment and Self-Care practices among pregnant women. *Alexandria Sci Nurs J*. 2020;22(2):19–26.
18. Cannella BL, Yarcheski A, Mahon NE. Meta-Analyses of Predictors of Health Practices in pregnant women. *West J Nurs Res*. 2018;40(3):425–46.
19. Jeon S, Noh W. Psychosocial factors associated with health behaviors in pregnant women of advanced maternal age in Korea. *Front Public Health*. 2023;11:1179416.
20. Salehi K, Salehi Z, Shaali M. The Effect of Education of Fetal Movement Counting on Maternal-Fetal Attachment in the pregnant women: a Randomized Controlled Clinical Trial. *Int J Pediatr*. 2017;5(4):4699–706.
21. Abasi E, Keramat A, Borghei NS, Goli S, Farjamfar M. Evaluating the effect of prenatal interventions on maternal-foetal attachment: a systematic review and meta-analysis. *Nurs Open*. 2021;8(1):4–16.
22. Boybay Koyuncu S, Bülbül M. The relationship between spousal support and health behaviors of pregnant women in Turkey. *J Midwifery Reproductive Health*. 2021;9(4):2936–42.
23. Urizar GG Jr, Murillo J, Miller K. Factors associated with prenatal health behaviors among low-income, ethnic minority women. *Int J Environ Res Public Health*. 2023;20(3):1695.
24. Chen CJ, Chen YC, Sung HC, Kuo PC, Wang CH. Perinatal attachment in naturally pregnant and infertility-treated pregnant women in Taiwan. *J Adv Nurs*. 2011;67(10):2200–8.
25. Mehran P, Simbar M, Shams J, Ramezani-Tehrani F, Nasiri N. History of perinatal loss and maternal-fetal attachment behaviors. *Women Birth: J Australian Coll Midwives*. 2013;26(3):185–9.
26. Cuijilits I, van de Wetering AP, Endendijk JJ, van Baar AL, Potharst ES, Pop VJM. Risk and protective factors for pre- and postnatal bonding. *Infant Mental Health J*. 2019;40(6):768–85.
27. Nosraty A, Mirzakhani K, Golmakani N, Esmaili H, Nekah A. Effect of attachment training on paternal-fetal attachment. *J Midwifery Reproductive Health*. 2019;7(2):1615–22.
28. Kuo PC, Bowers B, Chen YC, Chen CH, Tzeng YL, Lee MS. Maternal-foetal attachment during early pregnancy in Taiwanese women pregnant by in vitro fertilization. *J Adv Nurs*. 2013;69(11):2502–13.
29. Cercer Z, Yikar SK, Nazik E, Gezer D, Arslan S, Urunsak IF. Maternal-infant and paternal-infant attachment levels after successful infertility treatment and affecting factors: a descriptive cross-sectional study. *J Pediatr Nurs*. 2024;77:183–9.

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