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Psychometric evaluation of the Brazilian version of the Maternal-Fetal Attachment Scale

Avaliação psicométrica da versão brasileira da Escala de Apego Materno-Fetal

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Abstract

Objective

This study aimed to evaluate the psychometric properties of the Brazilian version of the Maternal-Fetal Attachment Scale applied to pregnant women in Primary Health Care.

Method

This is a methodological study conducted with 937 pregnant women assisted in the Family Health Strategy in Montes Claros, Minas Gerais, Brazil. Psychometric sensitivity, construct and criterion validity, and reliability were evaluated.

Results

The instrument achieved adequate psychometric sensitivity (skewness < 3 and kurtosis < 7). Quality fit indicators of the model were obtained: $\chi^2/df = 4.72$, CFI = 0.89, GFI = 0.90, TLI = 0.87, RMSEA = 0.063 (90% CI = 0.059-0.067, $p = 0.000$). Hypothesis testing indicated associations with marital status ($p = 0.036$), income ($p = 0.030$), trimester ($p < 0.001$), planned pregnancy ($p = 0.003$), social support ($p < 0.001$), and family APGAR score ($p < 0.001$). Significant correlations ($p < 0.001$) with stress ($r = -0.12$) and depressive symptoms ($r = -0.17$) demonstrated divergent criterion validity. Cronbach's α of 0.874 was recorded.

Conclusion

The scale showed adequate psychometric evidence for application to pregnant women in the Primary Health Care setting.

Keywords: Epidemiology; Maternal-fetal relations; Primary health care; Psychometrics; Validation study.



Resumo

Objetivo

Este estudo teve por objetivo avaliar as propriedades psicométricas da versão brasileira da Escala de Apego Materno-Fetal, aplicada às gestantes da Atenção Primária à Saúde.

Método

Estudo metodológico, realizado com 937 gestantes assistidas na Estratégia Saúde da Família, em Montes Claros, Minas Gerais – Brasil. Avaliaram-se sensibilidade psicométrica, validade de construto, validade de critério e confiabilidade.

Resultados

O instrumento alcançou adequada sensibilidade psicométrica (assimetria < 3 e curtose < 7). Obtiveram-se os indicadores de qualidade do ajuste do modelo: $\chi^2/gf = 4,72$, CFI = 0,89, GFI = 0,90, TLI = 0,87, RMSEA = 0,063 (90% = 0,059-0,067, $p = 0,000$). O teste de hipóteses indicou associações com estado conjugal ($p = 0,036$), renda ($p = 0,030$), trimestre ($p < 0,001$), gestação planejada ($p = 0,003$), apoio social ($p < 0,001$) e APGAR familiar ($p < 0,001$). Correlações significantes ($p < 0,001$) com estresse ($r = -0,12$) e sintomas depressivos ($r = -0,17$) evidenciaram a validade de critério divergente. Registrou-se α de Cronbach de 0,874.

Conclusão

A escala apresentou evidências psicométricas adequadas para aplicação a gestantes no cenário da Atenção Primária à Saúde.

Palavras-chave: Atenção primária à saúde; Epidemiologia; Estudo de validação; Psicometria; Relações materno-fetais.

Maternal-Fetal Attachment (MFA) is related to the concept of socioemotional development, which considers the existence of an innate human need to form intimate emotional bonds with significant individuals throughout life (Bowlby, 2002). A concept developed by Cranley (1981), MFA constitutes the first part of a continuum of attachment that starts in embryonic form during gestation and extends to the relationship between mother and baby in the postnatal period (Perrelli et al., 2014; Salehi et al., 2019; Schmidt & Argimon, 2009). It is defined as the intensity with which the pregnant woman manifests affiliation and integration behaviors with her intrauterine child (Cranley, 1981). It involves the woman's behaviors and attitudes in adapting to pregnancy, based on cognitive representations that include the mother's imagination and her expectations about the physical and emotional characteristics of the fetus (Cranley, 1981; Rubertsson et al., 2015; Schmidt & Argimon, 2009).

The MFA is seen as a universal construct but may have specific meanings according to sociocultural variations in different contexts and countries (Mesman et al., 2018; Navarro-Aresti et al., 2016; Noblega et al., 2019). It has been the subject of increasing clinical and scientific interest (Napoli et al., 2020; Teixeira et al., 2016), but it is still not fully clear, and its attention from a care perspective is incipient (Rubertsson et al., 2015). Furthermore, there are but few valid and reliable instruments that allow for the appropriate assessment of MFA (Busonera et al., 2017; Castaño et al., 2019; Perrelli et al., 2014).

The Maternal Fetal Attachment Scale (MFAS), the first instrument developed for MFA research, was created by Cranley in 1981 in the United States of America (USA) (Cranley, 1981). Subsequently, it underwent translation and validation in several languages, becoming one of the most widely used scales (Andrek et al., 2016; Castaño et al., 2019; McNamara et al., 2019). Its psychometric properties were analyzed in investigations conducted internationally, such as in Germany (Doster et al., 2018), Hungary (Andrek et al., 2016), Italy (Busonera et al., 2016; Lauriola et al., 2010), and India (Lingeswaran & Bindu, 2012). The settings were outpatient and hospital services (Andrek et

al., 2016; Busonera et al., 2016; Doster et al., 2018; Lauriola et al., 2010; Lingeswaran & Bindu, 2012), and so far, no psychometric evaluation has been identified with pregnant women assisted in Primary Health Care (PHC). In Brazil, it is called the *Escala de Apego Materno-Fetal* and is the tool used for assessing MFA, which underwent the process of translation, transcultural adaptation, reliability analysis, and construct validation (Feijó, 1999).

The use of a high-level psychometric measurement instrument (Mokkink et al., 2016) is necessary for the reliable measurement of the construct in question. With adequate psychometric qualities, the instrument can also promote potential adaptations in prenatal care to identify and assist pregnant women who have difficulty establishing an emotional bond with the fetus (Busonera et al., 2017; Busonera et al., 2016). Furthermore, it can facilitate cross-cultural comparisons between national and international research (Navarro-Aresti et al., 2016; Perrelli et al., 2014).

However, little is known about the reliability and validity parameters of the MFAS in other populations (Roncallo et al., 2015), such as pregnant women in the community setting receiving care in PHC services. Unprecedented application of the scale in different geographical regions requires a new psychometric analysis. Such analysis is important as it provides evidence of how measurement properties were evaluated and assists researchers and professionals in choosing the best tools for use, ensuring quality in the identified results (Mokkink et al., 2016; Souza et al., 2017).

The present study aimed to evaluate the psychometric properties of the Brazilian version of the MFAS applied to pregnant women in PHC.

Method

This is a methodological study derived from the main research project titled "*Estudo ALGE - Avaliação das Condições de Saúde das Gestantes de Montes Claros, MG: estudo longitudinal*" (ALGE Study - Evaluation of the Health Conditions of Pregnant Women in Montes Claros - MG: A Longitudinal Study) conducted in the city of Montes Claros, located in the Northern region of the state of Minas Gerais (MG), Brazil.

Participants

The population of this research consisted of pregnant women registered in the Family Health Strategy (FHS) teams in the urban area of the municipality in 2018. The sample size was determined to estimate population parameters with a prevalence of 50% (to maximize the sample size and due to the project encompassing various events), a 95% Confidence Interval (CI), and a precision level of 2.0%. A correction was made for a finite population ($n = 1,661$ pregnant women), and a 20% increase was established to compensate for possible non-responses and losses. The calculations indicated the need for the participation of at least 1,180 pregnant women.

A total of 1,278 pregnant women participated in the study. However, as this study included only data from women in the second and third trimesters of pregnancy, the sample totaled 937 participants. This is because the MFAS has specific items related to fetal movements which are more noticeable from the second trimester onwards (Busonera et al., 2016; Schmidt & Argimon, 2009). This sample size met the recommendations of Hair et al. (2009), which consider five to ten individuals needed per estimated parameter (k) in structural equation models, which in this research was equal to 24.

For the sample selection, the FHS hubs of the municipality were considered, totaling 15 during the research period, with 125 family health teams distributed among them. The number of

pregnant women sampled in each hub was proportional to their representativeness in relation to the total population of registered pregnant women.

Pregnant women registered with a family health team in PHC, at any gestational age, were included. Women pregnant with twins and those with cognitive impairments, as reported by family members and/or the FHS team, were excluded.

Instruments

A structured questionnaire was used, which included sociodemographic (marital status, age group, family income) and clinical variables (gestational trimester, pregnancy planning, parity). Instruments were also employed to investigate MFA, social support, family APGAR, perceived stress, and depressive symptoms.

To assess MFA, the Brazilian version of the MFAS was administered. This scale consists of 24 items with a Likert-type scoring with five response options: almost always, often, sometimes, rarely, and never, with scores ranging from five to one, respectively. The minimum score is 24, and the maximum is 120 (Feijó, 1999). A higher sum score indicates a stronger attachment towards the fetus. The following classification scores are established: low attachment (24 to 47 points), medium (48 to 97), and high (98 to 120) (Ruschel et al., 2014). The instrument is subdivided into the following five subscales: Differentiation of Self from Fetus (DSF); Interacting with the Fetus (IF); Attributing Characteristics to the Fetus (ACF); Giving of Self (GS); and Role Taking (RT) (Feijó, 1999).

To measure the presence of social support, the Brazilian version of the Social Support Scale was administered, composed of 19 questions encompassing five dimensions: material, affective, emotional, positive social interaction, and informational. For each item, participants indicate the frequency at which they perceive each type of support using a Likert-type scale: never 1), rarely 2), sometimes 3), almost always 4), and always 5). The closer the final score is to 100, the better the perceived social support (Griep et al., 2005). The overall scale score was calculated by summing up the total scores of the 19 items; a score above 66, corresponding to the second tertile, was considered as high social support (Rocha et al., 2016).

To assess the pregnant woman's perception of family functioning, the Family APGAR instrument was applied, which assesses the fulfillment of basic parameters defined by the acronym APGAR: A - Adaptation; P - Participation; G - Growth; A - Affection; R - Resolution. The questionnaire consists of five questions with three response options each, scored from zero to two points - Almost always (2), Some of the time (1), and Hardly ever (0). Thus, the total score ranges from zero to ten points, where a higher score indicates greater participant satisfaction. Categorization was performed into "functional family" (score of 7-10) and "dysfunctional family" (< 6) (Duarte, 2001).

Stress was assessed using the Perceived Stress Scale (PSS-14), an instrument that identifies situations in an individual's life judged as stressful, establishing levels of intensity. The questions are of a general nature and apply to any population subgroup, including pregnant women. It consists of 14 items regarding the frequency of experiencing certain feelings and thoughts in the past month, with responses ranging from zero (never) to four (very often). The score is obtained by reversing the scores of positive items and summing the responses of the 14 items, resulting in a total score ranging from zero to 70 (Luft et al., 2007).

Depressive symptoms were evaluated using the Center for Epidemiologic Studies Depression Scale (CES-D), a validated instrument in Brazil (Silveira & Jorge, 1998). The CES-D consists of 20 items,

of which four are positive, where the respondent reports the frequency of symptom occurrence in the past week. Each response can involve four increasing levels of intensity, measured on a Likert-type scale – rarely or none of the time, some or a little of the time, occasionally or a moderate amount of time, and all of the time – with corresponding scores of 0, 1, 2, and 3. The score of the four positive items is reversed and added to the score of the remaining items, resulting in a final score ranging from zero to 60 points (Fernandes & Rozenhal, 2008; Ribeiro et al., 2019; Silveira & Jorge, 1998).

The perceived stress and depressive symptoms scales were treated as numerical variables, based on their total scores.

Procedures

Regarding the data collection process, first, contact was made with the PHC coordination in the municipality to raise awareness and explain the purpose of the research. After obtaining consent, the family health teams were also visited by the researchers to provide clarifications about the study. The professionals from these teams, responsible for prenatal care, provided a list of pregnant women in their coverage area, including their names, phone numbers, and addresses. A team of interviewers then made initial phone contact with the women, approaching them with an invitation and sensitizing them about the study, so that data collection could be scheduled and carried out.

Data collection took place between October 2018 and November 2019, either at the PHC health units or at the participants' homes, depending on their availability. A multiprofessional team composed of healthcare professionals and undergraduate research students was responsible for conducting in-person interviews.

The interviewers were trained prior to data collection, and a pilot study was conducted with pregnant women registered at a PHC unit (who were not included in the study analyses) to standardize the research procedures.

Data Analysis

The psychometric properties of the MFAS were estimated through psychometric sensitivity, construct validity (factorial and hypothesis testing), divergent criterion validity, and reliability (internal consistency).

Descriptive analysis and psychometric sensitivity analysis of the instrument, as well as the items and subscales (factors), were conducted using measures such as the mean, standard deviation (\pm SD), and minimum and maximum values. Psychometric sensitivity was investigated based on the distribution pattern and normality of the sample data, which was met by considering the absolute values of kurtosis < 7 and skewness < 3 (Maroco, 2010).

In the examination of factorial construct validity, Confirmatory Factor Analysis (CFA) was performed. The quality of model fit for each item was considered adequate if the factor loading was equal to or greater than 0.40 (Laros, 2004). Indices used to judge the adequacy of the overall model fit included: the ratio of chi-square to degrees of freedom (χ^2/df), Confirmatory Fit Index (CFI), Goodness of Fit Index (GFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). The model fit was considered adequate if $\chi^2/df \leq 5.0$; CFI, GFI, and TLI ≥ 0.90 ; and RMSEA < 0.10 (Maroco, 2010).

For the analysis of hypothesis testing, the Mann-Whitney U test or Kruskal-Wallis test was used to compare the scale scores stratified into different groups of pregnant women who hypothetically

could present different levels of MFA. For this purpose, marital status, age group, family income, gestational trimester, pregnancy planning, parity, social support, and family APGAR were the variables tested. A significance level of 5% ($p < 0.05$) was adopted for rejecting the null hypothesis.

Divergent criterion validity was assessed by calculating the correlations of the total scale score with perceived stress and depressive symptoms. In examining this property, the Spearman correlation coefficient was used, considering coefficients with a p -value ≤ 0.05 as statistically significant (Maroco, 2010). Regarding the magnitude of correlations, results between 0.10 and 0.29 indicate weak correlation; between 0.30 and 0.49, moderate correlation; and between 0.50 and 1.00, strong correlation (Cohen, 1988).

The measure of reliability was assessed by examining internal consistency through the Cronbach's alpha coefficient (α) for the overall scale and each of its subscales. A standardized Cronbach's α value ≥ 0.70 was adopted as satisfactory (Hair et al., 2009; Maroco & Garcia-Marques, 2006). Correlations of items with the total scale and its factors (subscales) were also calculated, as well as Cronbach's α if an item was excluded from the scale or its respective subscale.

Data organization and processing were performed using IBM®SPSS® Statistics 22 software (IBM Corp., Armonk, NY, USA), where they underwent quality control and double verification. Statistical analyses were conducted using IBM®SPSS® Statistics 22 software (IBM Corp., Armonk, NY, USA) and Analysis of Moments Structures Software (AMOS®) 22.0 (IBM Corp., Armonk, NY, USA).

The study followed international and Brazilian ethical standards for research involving human subjects. The research project was approved by the Brazilian Research Ethics Committee (Opinion No. 2.483.623/2018) and authorized by the PHC Coordination of the Municipal Health Department. Adult participants provided the Informed Consent Form. Those under 18 years of age provided the Assent Form, as well as the Informed Consent Form signed by their legal guardians.

Results

Regarding the characteristics of the surveyed sample of 937 participants, it was observed that 433 (47.7%) were in the age range of 21 to 30 years, 721 (77.2%) reported being in a marital relationship, and 422 (46.7%) had a monthly family income of up to 1,000 reais. Among the interviewees, 515 (55.0%) were in the 2nd trimester and 422 (45.0%) in the 3rd, 564 (61.0%) reported unplanned pregnancies, and 448 (48.7%) were nulliparous.

Regarding the MFAS scores, a total score of 92.56 (± 15.32) was observed, with the lowest score in the DSF subscale, 16.16 (± 3.36), and the highest in the ACF subscale, 21.36 (± 5.13). The maximum values of skewness and kurtosis measures for the scale items were -2.00 and 5.1, respectively, while for the total scale, they were -0.7 and 1.0. These results suggest adequate psychometric sensitivity and not overly severe deviations from normal distribution (Table 1).

Figure 1 presents the results of data adequacy for the MFAS five-factor factorial structure, obtained through CFA. Most items (79.2%) had factor loadings greater than 0.40. The correlations between the factors of the instrument ranged from 0.49 to 0.91. The model fit indicators were as follows: $\chi^2/df = 4.72$, CFI = 0.89, GFI = 0.90, TLI = 0.87, RMSEA = 0.063 (90% CI = 0.059-0.067, $p = 0.000$).

In the hypothesis test, statistically significant associations of MFA were observed with the following variables: marital status ($p = 0.036$), family income ($p = 0.030$), gestational trimester ($p < 0.001$), planned pregnancy ($p = 0.003$), social support ($p < 0.001$), and family APGAR ($p < 0.001$) (Table 2).

Table 1

Descriptive and psychometric sensitivity measures of the Maternal-Fetal Attachment Scale. Montes Claros, Minas Gerais, Brazil, 2018-2019. (n = 937)

Item	Mean	Standard Deviation ±	Minimum	Maximum	Skewness	Kurtosis
1	4.1	1.7	1.0	5.0	-1.3	1.1
2	4.4	0.8	1.0	5.0	-1.8	3.8
3	4.2	1.2	1.0	5.0	-1.7	2.1
4	4.3	0.9	1.0	5.0	-1.7	2.8
5	4.4	0.8	1.0	5.0	-2.0	4.8
6	3.5	1.5	1.0	5.0	-0.6	-1.0
7	2.6	1.7	1.0	5.0	0.4	-1.5
8	4.4	0.9	1.0	5.0	-1.9	4.2
9	3.3	1.5	1.0	5.0	-0.4	-1.3
10	4.3	0.9	1.0	5.0	-1.0	-0.6
11	4.2	1.1	1.0	5.0	-1.5	1.5
12	4.3	1.0	1.0	5.0	-1.7	2.7
13	3.7	1.6	1.0	5.0	-0.9	-0.8
14	4.2	1.9	1.0	5.0	-1.5	1.7
15	4.3	0.9	1.0	5.0	-1.5	2.3
16	3.7	1.4	1.0	5.0	-0.8	-0.7
17	3.5	1.5	1.0	5.0	-0.6	-1.1
18	4.4	0.8	1.0	5.0	-2.0	5.1
19	4.4	0.9	1.0	5.0	-1.9	3.7
20	4.0	1.3	1.0	5.0	-1.3	0.5
21	2.3	1.6	1.0	5.0	0.6	-1.2
22	3.7	1.5	1.0	5.0	-0.7	-0.9
23	4.2	1.0	1.0	5.0	-1.6	2.1
24	2.5	1.7	1.0	5.0	0.5	-1.4
Subscales						
DSF	16.2	3.4	4.0	20.0	-0.8	0.6
IF	16.7	4.8	5.0	25.0	-0.3	-0.4
ACF	21.4	5.1	6.0	30.0	-0.4	-0.1
GS	20.8	3.3	6.0	25.0	-0.9	1.1
RT	17.5	2.9	4.0	20.0	-1.5	3.2
Scale total	92.6	15.3	29.0	120.0	-0.7	1.0

Note: ACF: Attributing Characteristics to the Fetus; DSF: Differentiation of Self from Fetus; GS: Giving of Self; IF: Interacting with the Fetus; RT: Role Taking.

The negative and statistically significant correlations of the total score of the scale with perceived stress ($r = -0.12, p < 0.001$) and depressive symptoms ($r = -0.17, p < 0.001$) demonstrated the divergent criterion validity of the instrument.

Table 3 presents the results of internal consistency. It also describes the item correlations with the total scale and factors, as well as the Cronbach's alpha (α) if an item is excluded from the scale or its respective subscale. The MFAS exhibited a Cronbach's alpha of 0.874 (95% CI = 0.863-0.886). The Cronbach's alpha values for the five subscales ranged from 0.519 (95% CI = 0.467-0.568) in DSF to 0.822 (95% CI = 0.802-0.840) in the RT subscale.

Figure 1
 Factor structure of the Maternal-Fetal Attachment Scale. Montes Claros, Minas Gerais, Brazil. (n = 937)

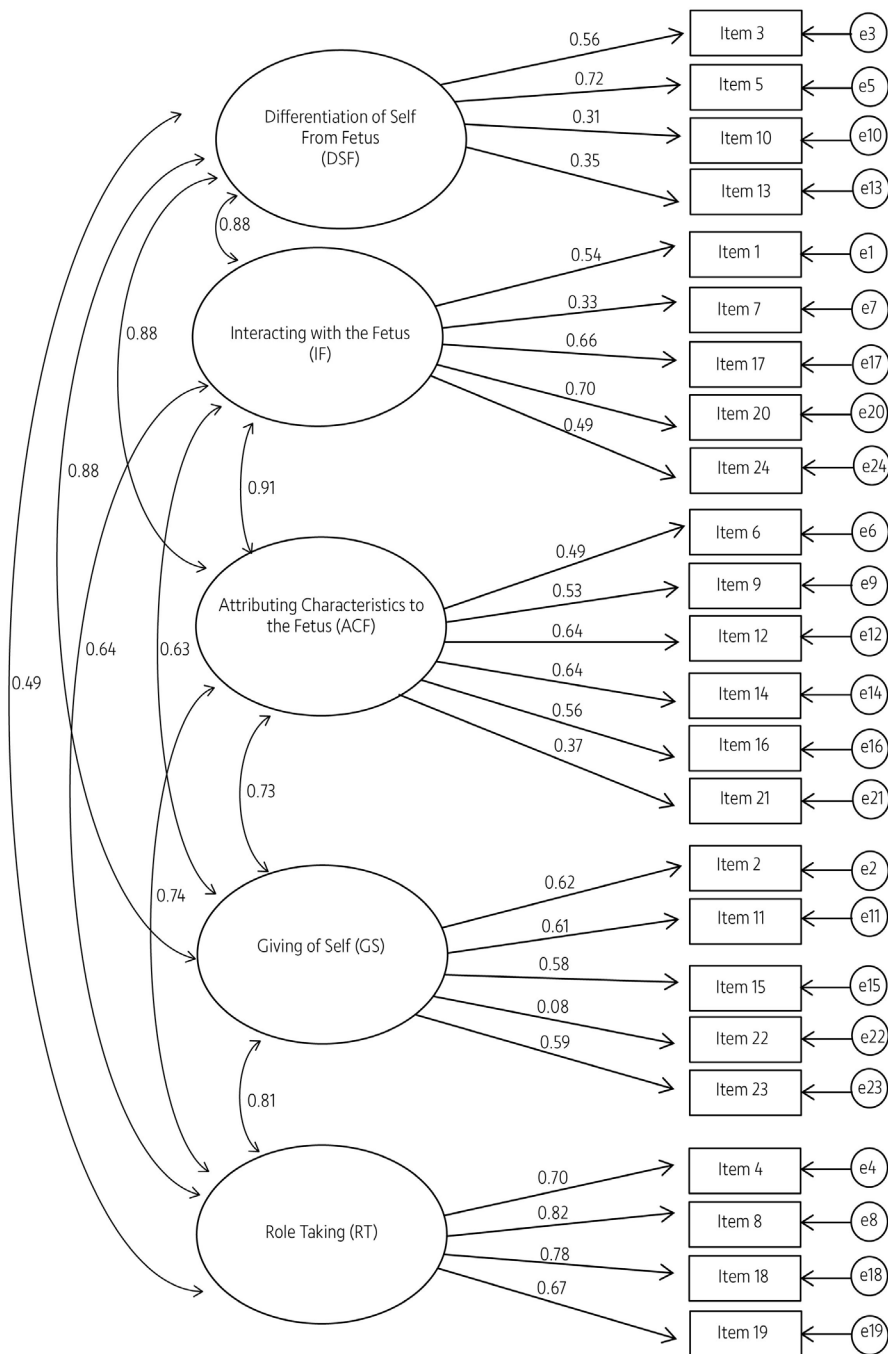


Table 2

Hypothesis test: comparison of Maternal-Fetal Attachment Scale scores according to selected variables. Montes Claros, Minas Gerais, Brazil, 2018–2019. (n = 937)

Variables	Mean	Standard Deviation ±	Median	Interquartile range	p-value
Marital status					0.036*
With partner	93.2	15.0	94.0	20.0	
Without partner	90.4	16.0	92.0	19.6	
Age range (in years)					0.240**
≤ 20	91.9	13.7	93.0	19.0	
21 to 30	93.5	15.2	94.0	21.0	
> 30	91.7	16.6	93.0	21.2	
Monthly family income (in Reais)					0.030**
≤ 1,000.00	91.1	15.8	92.0	20.0	
1,001.00 to 2,000.00	93.7	14.9	94.0	20.6	
> 2,000.00	94.1	14.8	95.0	19.7	
Gestational trimester					< 0.001*
Second	89.0	16.2	90.0	20.0	
Third	96.8	12.9	97.0	18.0	
Planned pregnancy					0.003*
Yes	94.6	13.9	95.0	19.7	
No	91.1	15.9	92.0	21.0	
Parity					0.244**
Nulliparous	93.3	14.8	94.0	20.0	
Primiparous	92.7	14.9	94.0	19.0	
Multiparous	90.52	16.8	92.0	23.2	
Social support					< 0.001*
Low	87.4	17.1	88.0	20.5	
High	93.6	14.7	94.0	20.0	
Family APGAR					< 0.001*
Functional family	93.9	14.2	94.0	20.0	
Dysfunctional family	85.2	18.9	86.0	23.0	

Note: *Mann-Whitney U test; **Kruskal-Wallis test.

Table 3

Measures of item-total correlation, item-factor correlation, and Cronbach's alpha for the Maternal-Fetal Attachment Scale. Montes Claros, Minas Gerais, Brazil, 2018–2019. (n = 937)

Subscales/items	Parameters				Cronbach's α (95% CI)
	Item-total correlation	Item-factor correlation	Cronbach's α if excluded item		
			Scale	Subscale	
Differentiation of Self From Fetus					0.520 (0.467-0.568)
3	0.578	0.307	0.866	0.453	
5	0.575	0.421	0.868	0.416	
10	0.343	0.287	0.874	0.481	
13	0.358	0.316	0.873	0.452	
Interacting with the Fetus					0.664 (0.629-0.697)
1	0.515	0.380	0.868	0.635	
7	0.346	0.304	0.874	0.674	
17	0.538	0.520	0.867	0.563	
20	0.604	0.492	0.865	0.584	
24	0.453	0.443	0.870	0.602	
Attributing Characteristics to the Fetus					0.691 (0.660-0.721)
6	0.445	0.449	0.870	0.641	
9	0.499	0.441	0.868	0.645	
12	0.555	0.441	0.867	0.652	
14	0.554	0.482	0.867	0.639	
16	0.500	0.431	0.868	0.647	
21	0.349	0.346	0.873	0.681	
Giving of Self					0.575 (0.531-0.617)
2	0.493	0.414	0.870	0.494	
11	0.462	0.434	0.869	0.459	
15	0.438	0.465	0.870	0.459	
22	-0.001	0.118	0.884	0.687	
23	0.453	0.383	0.870	0.494	
Role Taking					0.822 (0.802-0.840)
4	0.548	0.596	0.868	0.801	
8	0.602	0.718	0.867	0.742	
18	0.561	0.717	0.868	0.748	
19	0.569	0.572	0.867	0.811	
Total					0.874 (0.863-0.886)

Discussion

This study demonstrated satisfactory criteria for psychometric sensitivity, construct validity (factor structure and hypothesis testing), criterion validity (divergent), and reliability (internal consistency) of the Brazilian version of the MFAS applied to pregnant women assisted in the FHS. Meeting these parameters in the sampled population is important and necessary, as it shows that this scale has adequate psychometric attributes even when applied to different populations (Andrek et al., 2016; Doster et al., 2018). It is one of the few specific instruments for assessing MFA and has been widely used since the 1980s (Andrek et al., 2016; McNamara et al., 2019; Rollè et al., 2020).

The MFA represents a subjective measure in health and is difficult to conceptualize, requiring satisfactory psychometric evidence regarding validity and reliability parameters for adequate evaluation (Baptista et al., 2019; Cunha et al., 2016). These pieces of evidence cannot be treated as absolute attributes, as for each context/purpose of scale utilization and intended interpretation, scores must have indications of validity and reliability. The process of validating an instrument encompasses development and accumulation of information that supports interpretations based on test results and their application in different realities (Baptista et al., 2019), such as the Brazilian PHC.

The MFAS demonstrated construct-related validity, as evidenced by factorial validity through the CFA method. Through this analysis, it was observed that the evaluated construct is explained by the scale's five factors. The factor loadings of the items, for the most part, reached high values, indicating that they accurately represent the behavioral aspects of the latent factors they aim to assess (Pasquali, 2017).

It is considered that ACF showed reasonable results: the TLI for adjustment quality was lower than recommended, the CFI had a borderline result, and 5 of the 24 items had low factor loadings. In this study, items 7, 10, 13, 21, and 22 had factor loadings lower than recommended, while in an Italian study, in addition to items 10 and 13, items 2, 5, 11, 12, 15, and 23 were unsatisfactory (Busonera et al., 2016). Research has demonstrated concerns regarding the representation of the construct by the MFAS and the fit of the five-factor model (Andrek et al., 2016; Busonera et al., 2016; Doster et al., 2018; Lauriola et al., 2010). Based on exploratory factor analysis conducted in Germany (Doster et al., 2018) and CFA in Italy (Busonera et al., 2016), a three-factor solution was proposed, which yielded a better fit to the model.

There are suggestions to revise items and subscales to enhance their contribution to the scale and alignment with the construct (Andrek et al., 2016; Busonera et al., 2016). Items with unsatisfactory factor loadings may be describing situations and behaviors that may not be part of the behavioral repertoire of the analyzed sample or were poorly assessed and/or understood. It is evident that there is still insufficient evidence to recommend the absolute use of the instrument with five factors or three. This highlights the need for further research to improve the initially examined dimensional structure, with the aim of enhancing the scale, considering the multidimensionality of the MFA construct.

There is an explanation that these factorial validity results may occur because the factors of the MFAS were not subjected to more rigorous statistical analyses during their creation (Doan et al., 2003), such as exploratory and confirmatory factor analyses. During the translation and validation process of this scale in Brazil, the author noted limitations in its semantic content that may have affected construct validity (Feijó, 1999). It is hoped that the findings obtained can guide the refinement of the instrument's factorial structure (Andrek et al., 2016). It is worth considering that the more abstract the concept, the more difficult it is to establish structural validity (Souza et

al., 2017). The construct in question has theoretical peculiarities that may go beyond the statistical aspect (Lauriola et al., 2010; Lingeswaran & Bindu, 2012).

The construct validity parameter was confirmed in the current study, as it was also supported by the scale's ability to differentiate MFA scores according to marital status, family income, pregnancy trimester and planning, as well as social support and family APGAR. These results demonstrate that recognizing associated and modifiable variables is essential for improving clinical and investigative practice. In other validation studies, the association of MFA with cohabitation status and gestational age was also reported in Hungary (Andrek et al., 2016), and with the third trimester and social support in a sample of Italian pregnant women (Busonera et al., 2016). Unlike this study, in other studies with psychometric analysis of the MFAS, no statistically significant results were observed regarding the relationship between MFA and income (Andrek et al., 2016; Doster et al., 2018) and pregnancy planning (Andrek et al., 2016).

The existence of validity suggested by the hypothesis testing is relevant as it can provide parameters for comparing scores according to individual aspects that influence attachment, especially when considering the novel associations indicated in this investigation. The MFA is a multidimensional construct linked to a series of predictive factors, whether sociodemographic, clinical, psychosocial, or psychopathological in nature (Koss et al., 2016; McNamara et al., 2019; Rollè et al., 2020). Good socioeconomic conditions, satisfactory social support, and functional family relationships are considered favorable attributes for MFA quality (Andrek et al., 2016; Lingeswaran & Bindu, 2012; McNamara et al., 2019; Rollè et al., 2020). Interpretations and considerations that consider this multifactorial aspect should be established (Andrek et al., 2016; Lingeswaran & Bindu, 2012) within research and prenatal care for pregnant women, especially in a sociocultural and economic context different from previous instrument validation studies.

The Brazilian version of the MFAS also demonstrated divergent criterion validity, as its total score was negatively and significantly correlated with scores of perceived stress and depressive symptoms. International psychometric studies did not find a relationship between these constructs and MFA (Andrek et al., 2016; Busonera et al., 2016; Doster et al., 2018; Lingeswaran & Bindu, 2012), revealing a novel and positive aspect of the Brazilian version in the studied sample.

The choice to analyze the instrument's correlations with these parameters was motivated by the absence of a translated and validated "gold standard" scale for measuring MFA in the country. Therefore, concurrent validity could not be assessed. Issues such as stress and depressive symptoms can affect the emotional dimension of the pregnant woman and compromise the establishment of a healthy relationship with the fetus (Busonera et al., 2016; Cavalcante et al., 2017; Ozcan et al., 2019). It is worth noting that these dimensions and their interface with the analyzed construct (McNamara et al., 2019) should be recognized as evidence that can promote the implementation of more individualized prenatal care (Andrek et al., 2016; Busonera et al., 2016), within the FHS, where the MFAS can also be used by professionals. Attention to women's mental health during prenatal care is important to prevent the onset or worsening of psychological problems that may have a negative impact on the mother-fetus relationship (Cavalcante et al., 2017).

The MFAS obtained high internal consistency in this research, indicating that the items are highly intercorrelated within the measure of the same latent construct and can measure without errors, a property that supports the accuracy of the tool (Hair et al., 2009; Pasquali, 2017). Regarding the subscales, only the RT dimension showed an adequate Cronbach's alpha value; ACF had a borderline result; DSF, IF, and GS were below the acceptable threshold. A similar situation regarding the scale and its subscales was identified in psychometric investigations conducted in

Germany (Doster et al., 2018), Hungary (Andrek et al., 2016), Italy (Busonera et al., 2016; Lauriola et al., 2010), and India (Lingeswaran & Bindu, 2012). The deficiency in the subscales' consistency had already been observed in the initial creation studies in the United States (Cranley, 1981) and in the validation study in Brazil (Feijó, 1999).

The measurement of Cronbach's alpha is strongly influenced by the number of variables in the constructs (Souza et al., 2017). In the instrument validation research in Brazil, it was pointed out that the subscales needed to be revised. They were found to contain mixed semantic content. It was recommended that the MFA construct be treated as a unidimensional scale, not to be divided into subscales, suggesting the use of the total scale score as a general measure of attachment (Feijó, 1999). Similarly, in another investigation conducted with Italian pregnant women, it was found that the reliability of the subscales was weakened due to the small number of items. The total scale was found to be more reliable than the subscale scores, but the subscales capture more specific aspects of the construct (Lauriola et al., 2010). These observations may explain, at least in part, the findings recorded in the present investigation. Given the results of internal consistency, the individual use and interpretation of subscale results requires caution.

It should be considered that reliability depends on the function of the instrument, the population in which it is administered, the circumstances, and the context (Cunha et al., 2016; Souza et al., 2017). For research purposes, a Cronbach's alpha coefficient below the recommended threshold may be considered acceptable if the results obtained with the instrument are interpreted in conjunction with other statistical measures. The value of the consistency estimated by this measure is an estimate of the data's reliability and informs the scale's precision. However, the obtained values are subject to the circumstances and population in which it was applied. Reliability is not a static measure, so lower values of Cronbach's alpha do not invalidate the quality of the instrument (Cunha et al., 2016; Maroco & Garcia-Marques, 2006; Souza et al., 2017).

Finally, the findings in this study imply the need to examine the understanding of the theoretical and cultural specificities of the items that represent the MFA construct. This, in turn, has implications for cross-cultural comparison of results derived from the MFAS. This is because there are uncertainties regarding the conceptualization of MFA at the international level, which may not be uniform in terms of the cultural, ethnic, educational, and religious diversity present in each region or country (Busonera et al., 2016; Lingeswaran & Bindu, 2012). The development of the scale took place in a developed Western country, a different context from Latin American countries, and there is a lack of evidence regarding women in situations of socioeconomic and psychosocial vulnerability, as well as diverse ethnic backgrounds (Roncallo et al., 2015). This situation highlights the relevance of adequately and contextually investigating the construct in pregnant women receiving prenatal care in PHC.

This research admits certain limitations. The analysis of concurrent validity was not possible because it was not possible to measure the correlation with another validated instrument that assesses the same construct, as such an instrument does not exist in Brazil. Although self-reporting is necessary for many measurements conducted in the field of health, it is susceptible to social desirability bias. Reproducibility should be examined in future research.

Conversely, it should be emphasized that this is an unprecedented validation of the MFAS in the context of PHC, and to date, no other national investigations have been conducted after the original validation study of the instrument in Brazil. Through a comprehensive epidemiological survey, a robust and heterogeneous sample from diverse communities and sociodemographic characteristics was evaluated. The surveyed pregnant women may thus have greater variability than those in other

studies with psychometric qualities, which were smaller in size and more homogeneous in terms of socioeconomic and educational factors.

Conclusion

The evaluated scale gathered satisfactory psychometric evidence regarding its psychometric sensitivity, reliability, construct validity, and divergent criterion validity. Despite certain reservations regarding the factorial structure and internal consistency of the subscales, the Brazilian version of the MFAS has been shown to be suitable for application to pregnant women receiving care in PHC services.

By appreciating the results of a research conducted in a community context, it is expected that the evaluation of the scale's quality has contributed to its legitimacy and credibility. Consequently, the instrument's potential for generating authentic epidemiological information is evident, which underpins the clinical, scientific, and humanized practice of family health professionals in providing care for pregnant women. It is suggested to conduct future research in other Brazilian states and regions, which may provide better factorial validity and reliability of the instrument's subscales.

References

- Andrek, A., Kekecs, Z., Hadhazi, E., Boukydis, Z., & Varga, K. (2016). Re-evaluation of the psychometric properties of the Maternal-Fetal Attachment Scale in a Hungarian sample. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 45(5), e15–e25. <https://doi.org/10.1016/j.jogn.2016.05.005>
- Baptista, M. N., Muniz, M., Reppold, C. T., Nunes, C. H. S. S., Carvalho, L. F., Primi, R., Noronha, A. P. P., Seabra, A. G., Wechsler, S., & Pasquali, L. (2019). *Compêndio da Avaliação Psicológica* (1st ed.). Vozes.
- Bowlby J. (2002). *Apego: A natureza do vínculo* (3rd ed.). Martins Fontes.
- Busonera, A., Cataudella, S., Lampis, J., Tommasi, M., & Zavattini, G. C. (2017). Prenatal attachment inventory: Expanding the reliability and validity evidence using a sample of Italian women. *Journal of Reproductive and Infant Psychology*, 35(5), 462–479. <https://doi.org/10.1080/02646838.2017.1349896>
- Busonera, A., Cataudella, S., Lampis, J., Tommasi, M., & Zavattini, G. C. (2016). Psychometric properties of a 20-item version of the Maternal-Fetal Attachment Scale in a sample of Italian expectant women. *Midwifery*, 34, 79–87. <https://doi.org/10.1016/j.midw.2015.12.012>
- Castaño, J. H. O., Carrascal, G. C., & Rodríguez, M. D. L. Á. G. (2019). Apego materno-fetal: Un análisis de concepto. *Revista Habanera de Ciencias Médicas*, 18(6), 969–982. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1729-519X2019000600969
- Cavalcante, M. C. V., Lamy, F., França, A. K. T. D. C., & Lamy, Z. C. (2017). Relação mãe-filho e fatores associados: análise hierarquizada de base populacional em uma capital do Brasil-Estudo BRISA. *Ciência & Saúde Coletiva*, 22(5), 1683–1693. <https://doi.org/10.1590/1413-81232017225.21722015>
- Cohen J. (1988). *Statistical power analysis for the behavioral sciences*. NJ Erlbaum.
- Cranley, M. S. (1981). Development of a tool for the measurement of maternal attachment during pregnancy. *Nursing Research*, 30(5), 281–284. <https://doi.org/10.1097/00006199-198109000-00008>
- Cunha, C. M., Almeida Neto, O. P., & Stackfleth, R. S. (2016). Principais métodos de avaliação psicométrica da confiabilidade de instrumentos de medida. *Revista de Atenção à Saúde*, 14(49), 98–103. <https://doi.org/10.13037/ras.vol14n49.3671>
- Doan, H. M., Cox, N. L., & Zimmerman, A. (2003). The maternal fetal attachment scale: Some methodological ponderings. *Journal of Prenatal & Perinatal Psychology & Health*, 18(2), 167–188.

- Doster, A., Wallwiener, S., Müller, M., Matthies, L. M., Plewniok, K., Feller, S., Kuon, R.-J., Sohn, C., Rom, J., Wallwiener, M., & Reck, C. (2018). Reliability and validity of the German version of the maternal-fetal attachment scale. *Archives of Gynecology and Obstetrics*, 297(5), 1157–1167. <https://doi.org/10.1007/s00404-018-4676-x>
- Duarte, Y. A. D. O. (2001). *Família: Rede de suporte ou fator estressor: A ótica de idosos e cuidadores familiares* [Tese de doutorado não-publicada]. Escola de Enfermagem da Universidade de São Paulo.
- Feijó, M. C. C. (1999). Validação brasileira da “Maternal-Fetal Attachment Scale”. *Arquivos Brasileiros de Psicologia Aplicada*, 51(4), 52–62.
- Fernandes, R. C. L., & Rozenenthal, M. (2008). Avaliação da sintomatologia depressiva de mulheres no climatério com a escala de rastreamento populacional para depressão CES-D. *Revista de Psiquiatria do Rio Grande do Sul*, 30(3), 192–200. <https://doi.org/10.1590/S0101-81082008000400008>
- Griep, R. H., Chor, D., Faerstein, E., Werneck, G. L., & Lopes, C. S. (2005). Validade de constructo de escala de apoio social do Medical Outcomes Study adaptada para o português no Estudo Pró-Saúde. *Cadernos de Saúde Pública*, 21(3), 703–714. <https://doi.org/10.1590/S0102-311X2005000300004>
- Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2009). *Análise multivariada de dados* (6th ed.). Bookman editora.
- Koss, J., Bidzan, M., Smutek, J., & Bidzan, L. (2016). Influence of perinatal depression on labor-associated fear and emotional attachment to the child in high-risk pregnancies and the first days after delivery. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*, 22, 1028–1037. <https://doi.org/10.12659/msm.895410>
- Laros, J. A. (2004). O uso da análise fatorial: Algumas diretrizes para pesquisadores. In L. Pasquali (Org.), *Análise fatorial para pesquisadores* (pp. 163–193). Vozes.
- Lauriola, M., Panno, A., Riccardi, C., & Tagliatela, D. (2010). La misura dell’ attaccamento materno prenatale: Un confronto psicométrico di tre strumenti di valutazione. *Infanzia e Adolescenza*, 9(3), 6403. <https://doi.org/10.1710/535.6403>
- Lingeswaran, A., & Bindu, H. (2012). Validation of tamil version of Cranley’s 24-item maternal-fetal attachment scale in indian pregnant women. *The Journal of Obstetrics and Gynecology of India*, 62(6), 630–634. <https://doi.org/10.1007/s13224-012-0175-3>
- Luft, C. D., Sanches, S. O., Mazo, G. Z., & Andrade, A. (2007). Versão brasileira da Escala de Estresse Percebido: tradução e validação para idosos. *Revista de Saúde Pública*, 41(4), 606–615. <https://doi.org/10.1590/S0034-89102007000400015>
- Maroco, J. P. (2010). *Análise de equações estruturais. Fundamentos teóricos, software & aplicações*. Report Number.
- Maroco, J. P., & Garcia-Marques, T. (2006). Qual é a fiabilidade do alfa de Cronbach? Questões antigas e soluções modernas? *Laboratório de Psicologia*, 4(1), 65–90. <https://repositorio.ispa.pt/handle/10400.12/133>
- McNamara, J., Townsend, M. L., & Herbert, J. S. (2019). A systemic review of maternal wellbeing and its relationship with maternal fetal attachment and early postpartum bonding. *PLoS One*, 14(7), e0220032. <https://doi.org/10.1371/journal.pone.0220032>
- Mesman, J., Minter, T., Angnged, A., Cissé, I., Salali, G. G., & Migliano, A. B. (2018). Universality without uniformity: A culturally inclusive approach to sensitive responsiveness in infant caregiving. *Child Development*, 89(3), 837–850. <https://doi.org/10.1111/cdev.12795>
- Mokkink, L. B., Prinsen, C. A. C., Bouter, L. M., Vet, H. C. W., & Terwee, C. B. (2016). The Consensus-based standards for the selection of health Measurement instruments (COSMIN) and how to select an outcome measurement instrument. *Brazilian Journal of Physical Therapy*, 20(2), 105–113. <https://doi.org/10.1590/bjpt-rbf.2014.0143>
- Napoli, A., Lamis, D. A., Berardelli, I., Canzonetta, V., Sarubbi, S., Rogante, E., Napoli, P.-L., Serafini, G., Erbuto, D., Tambelli, R., Amore, M., & Pompili, M. (2020). Anxiety, prenatal attachment, and depressive symptoms in women with diabetes in pregnancy. *International Journal of Environmental Research and Public Health*, 17(2), 425. <https://doi.org/10.3390/ijerph17020425>

- Navarro-Aresti, L., Iraurgi, I., Iriarte, L., & Martínez-Pampliega, A. (2016). Maternal Antenatal Attachment Scale (MAAS): Adaptation to Spanish and proposal for a brief version of 12 items. *Archives of Women's Mental Health, 19*, 95–103. <https://doi.org/10.1007/s00737-015-0513-4>
- Noblega, M., Barrig, P., & Fourmen, K. (2019). Maternal care and attachment security in preschool children. *Psicologia Teoria e Pesquisa, 35*, e3534. <https://doi.org/10.1590/0102.3772e3534>
- Ozcan, H., Ustundag, M. F., Yilmaz, M., Aydinoglu, U., Ersoy, A. O., & Eyi, E. G. Y. (2019). The relationships between prenatal attachment, basic personality traits, styles of coping with stress, depression, and anxiety, and marital adjustment among women in the third trimester of pregnancy. *The Eurasian Journal of Medicine, 51*(3), 232–236. <https://doi.org/10.5152/eurasianjmed.2019.15302>
- Pasquali, L. (2017). Validade dos testes. *Examen, 1*(1), 14–48. <https://examen.emnuvens.com.br/rev/article/view/19>
- Perrelli, J. G. A., Zambaldi, C. F., Cantilino, A., & Sougey, E. B. (2014). Mother-child bonding assessment tools. *Revista Paulista de Pediatria, 32*(3), 257–265. <https://doi.org/10.1590/0103-0582201432318>
- Ribeiro, S. V. O., Batista, R. F. L., Ribeiro, M. R. C., Pessoa, K. C., Simões, V. M. F., Figueiredo, F. P. D., & Bettiol, H. (2019). Violence and depressive symptoms during pregnancy in BRISA cohort: using structural equation modeling approach. *Revista Brasileira de Saúde Materno Infantil, 19*(1), 173–184. <https://doi.org/10.1590/1806-93042019000100010>
- Rocha, P. C., Britto e Alves, M. T. S. S., Chagas, D. C., Silva, A. A. M., Batista, R. F. L., & Silva, R. A. (2016). Prevalência e fatores associados ao uso de drogas ilícitas em gestantes da coorte BRISA. *Cadernos de Saúde Pública, 32*(1), e00192714. <https://doi.org/10.1590/0102-311X00192714>
- Rollè, L., Giordano, M., Santoniccolo, F., & Trombetta, T. (2020). Prenatal attachment and perinatal depression: A systematic review. *International Journal of Environmental Research and Public Health, 17*(8), 2644. <https://doi.org/10.3390/ijerph17082644>
- Roncallo, C. P., Miguel, M. S., & Freijo, E. A. (2015). Vínculo materno-fetal: Implicaciones en el desarrollo psicológico y propuesta de intervención en atención temprana. *Escritos de Psicología, 8*(2), 14–23. <https://doi.org/10.5231/psy.writ.2015.0706>
- Rubertsson, C., Pallant, J. F., Sydsjö, G., Haines, H. M., & Hildingsson, I. (2015). Maternal depressive symptoms have a negative impact on prenatal attachment – Findings from a Swedish community sample. *Journal of Reproductive and Infant Psychology, 33*(2), 153–164. <https://doi.org/10.1080/02646838.2014.992009>
- Ruschel, P., Zielinsky, P., Grings, C., Pimentel, J., Azevedo, L., Paniagua, R., & Nicoloso, L. H. (2014). Maternal-fetal attachment and prenatal diagnosis of heart disease. *European Journal of Obstetrics & Gynecology and Reproductive Biology, 174*, 70–75. <https://doi.org/10.1016/j.ejogrb.2013.11.029>
- Salehi, K., Taleghani, F., & Kohan, S. (2019). Effect of attachment-based interventions on prenatal attachment: A protocol for systematic review. *Reproductive Health, 16*, 42. <https://doi.org/10.1186/s12978-019-0704-y>
- Schmidt, E. B., & Argimon, I. I. L. (2009). Vinculação da gestante e apego materno fetal. *Paidéia, 19*(43), 211–220. <https://doi.org/10.1590/S0103-863X2009000200009>
- Silveira, D. X., & Jorge, M. R. (1998). Propriedades psicométricas da escala de rastreamento populacional para depressão CES-D em populações clínica e não-clínica de adolescentes e adultos jovens. *Revista de Psiquiatria Clínica, 25*(5), 251–261.
- Souza, A. C., Alexandre, N. M. C., & Guirardello, E. B. (2017). Psychometric properties in instruments evaluation of reliability and validity. *Epidemiologia e Serviços de Saúde, 26*(3), 649–659. <https://doi.org/10.5123/s1679-49742017000300022>
- Teixeira, M. I. F., Raimundo, F. M. M., & Antunes, M. C. Q. (2016). Relação da vinculação materno-fetal com a idade gestacional e as memórias parentais. *Revista de Enfermagem Referência, 4*(8), 85–92. <https://doi.org/10.12707/RIV15025>

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