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The Postpartum Bonding Questionnaire: validity evidence from the Brazilian version

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Abstract

The Postpartum Bonding Questionnaire is a self-report questionnaire designed to screen disorders of the mother-infant relationship, which has been adapted to several countries. The aim of this study was to investigate validity evidence of the Brazilian version of the Postpartum Bonding Questionnaire (PBQ-Br) based on its internal structure (dimensionality, reliability, and measurement invariance between mothers with and without depressive symptoms) and on relations to other variables (depression). The present study is part of the Ribeirão Preto and São Luís Brazilian Cohort Studies, encompassing data collected from February 2011 to September 2013. Data were available for 2207 mothers from the general population of Ribeirão Preto and São Luís cities, who were assessed using the PBQ and the Edinburgh Postnatal Depression Scale. Regarding internal structure, the results of confirmatory factor analyses did not support the original four-factor model, nor the alternative structures tested. Exploratory factor analysis suggested a one-factor model with eight items for the collected data, accounting for 38.7% of the total variance with good internal consistency ($\alpha = 0.83$). Concerning validity evidence based on relations to other variables, the mean PBQ-Br score for mothers with depressive symptoms was significantly higher than for mothers with no depressive symptoms. In conclusion, we found good validity evidence and the PBQ-Br proved to be a useful tool for assessing the mother-infant relationship in the Brazilian general population rather than for its original purpose, i.e., assessing bonding disorders. The results also highlight the importance of developing cross-cultural studies in order to provide useful measures for specific populations.

Keywords Maternal health · Validity · Reliability · Parent-child relations · Psychometric properties

Highlights

- PBQ-Br proved to be a useful tool for assessing the mother-infant relationship in Brazil.
- PBQ-Br is more suitable for assessing routine issues of the mother-infant relationship rather than for its original purpose, i.e., assessing bonding disorders.
- Data for PBQ-Br validity evidence were available for 2207 Brazilian mothers.

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- The results indicated a one-factor model with eight items as the best factor structure.
- The results highlight the importance of developing further cross-cultural research in order to assess this construct and measure it in other contexts.

The birth of a child is considered to be a period of many changes and challenges in a woman's life, both physical and psychological, making it a critical moment for maternal mental health and for the future development of the child (Freeman, 2019; Slade & Sadler, 2018). Since the development and establishment of the mother-infant relationship are idealized as key psychological processes during puerperium, bonding disorders may imply long-term psychosocial disadvantages for the baby (Brockington, 2016). Bonding disorders are defined as an abnormally strong lack of maternal feeling, irritability, hostility, aggressive impulses, pathological anger, and outright rejection. These disorders are prevalent in 10–25% of women who need psychiatric care (Brockington et al., 2006; Klier, 2006). In addition, there is a great controversy surrounding the concept of mother-infant bonding disorders since diagnosis, treatment and clinical research have been hampered by the lack of recognition of this phenomenon in the current classificatory systems (Diagnostic and Statistical Manual of Mental Disorders and International Classification of Diseases). Although some authors have proposed definitions in the behavioral and biological domains, most of them seem to agree that bonding disorders are processes based on the emotional feelings of a mother toward her child related to the affective domain (Barker et al., 2017; Hill & Flanagan, 2020). The main symptom of bonding disorders is the negative emotional response of the mother to the infant, expressed through feelings of aversion, hatred, or pathological anger. Thus, an impaired mother-infant relationship may increase the risk of child abuse and neglect, with possible negative developmental outcomes for the infant (Brockington, 2004). However, as with any major life change, it is normal for mothers to experience some level of negative emotions or ambivalence in the months before and after childbirth. These feelings can also vary culturally and the mother's stress level is definitely affected by several risk factors such as emotional and socioeconomic factors, maternal health conditions, lifestyle behaviors, social support, and partner-related stress (Saur & Dos Santos, 2021).

Another challenge related to the concept of maternal bonding disorders is how to systematize an assessment procedure that can be used to measure the process of "mother-infant bonding" (Bicking Kinsey & Hupcey, 2013). Although time- consuming, observational methods of maternal behavioral manifestations have been often reported in the literature as the gold standard measure of maternal bonding (Brockington et al., 2006). Another alternative consists of self-report instruments often applied in research and clinical practice, especially in large samples. One of the tools most frequently used worldwide for the assessment of bonding disorders is the Postpartum Bonding Questionnaire (PBQ), designed in the United Kingdom by Ian Brockington and colleagues as a screening instrument for the diagnosis of bonding disorders (Mason, 2015; Wittkowski et al., 2020). The original PBQ has 25 items organized into four subscales that reflect impaired bonding, rejection and anger, anxiety about care, and incipient abuse. The mothers included in the original adaptation study (Brockington et al., 2001) were recruited from a variety of sources (normal population, mothers of babies with fetal abnormalities, depressed mothers with a normal mother-infant relationship, and depressed mothers with various degrees of impaired mother-infant bonding); thus, the PBQ was originally designed to be applied to community samples and also to high risk samples (clinical patients).

The PBQ has already been validated for the population of England (Brockington et al., 2001; Wittkowski et al., 2010), Germany (Reck et al., 2006), Belgium (van Bussel et al., 2010), China (Siu et al., 2010), Portugal (Nazaré et al., 2011, 2012), Bangladesh (Edhborg et al., 2011), Spain (-Esteve et al., 2016), Turkey (Örün et al., 2013), United States (Kinsey et al., 2014), Japan (Kaneko & Honjo, 2014; Ohashi et al., 2016; Suetsugu et al., 2015), Italy (Busonera et al., 2017), and India (Vengadavaradan et al., 2019). In Brazil, Baldisserotto et al. (2018) only reported the translation of the PBQ and its adaptation to the Brazilian context, but no validity study was performed. Thus, there is an urgent need to develop adaptation studies addressing the mother-infant relationship for the Brazilian population.

It is worth noting that most of the PBQ adaptation studies across countries have yielded different structural models (i.e., different dimensionality), as shown in detail in Table 1. In short, four studies adopted a one-factor solution: Reck et al. (2006), Nazaré et al. (2012), Kinsey et al. (2014) and Kaneko and Honjo (2014), with a version of 16, 12, 10 and 16 items, respectively. Three studies adopted a three-factor solution: Wittkowski et al. (2010), Ohashi et al. (2016) and Busonera et al. (2017), with 22, 25 and 25 items, respectively. Four other studies decided to use a four-factor solution: Edhborg et al. (2011), Nazaré et al. (2011), Garcia-Esteve et al. (2016) and Suetsugu et al. (2015), with 24, 24, 25 and 14 items, respectively. Finally, a five-factor structure with 19 items was proposed for the first time by Vengadavaradan et al. (2019).

Table 1 Comparison of the dimensionality (factorial solution) adopted in the PBQ adaptation studies

Country	Reference/Year	Sample (*n*) Com/Cli*	Factors (*n* items)	Removed items	Factor Analysis
England	Brockington et al. 2001**	104 Com	4 (25)		PCA
German	Reck et al. 2006	862 Com	1 (16)	5, 6, 12, 17, 18, 20, 22, 23, 24	PCA
England	Wittkowski et al. 2010	132 Cli	3 (22)	18, 23, 24	CFA and EFA
Bangladesh	Edhborg et al. 2011	672 Com	4 (24)	20	PCA
Portugal	Nazaré et al. 2011	125 Com	4 (24)	6	PCA
Portugal	Nazaré et al. 2012	229 Com	1 (12)	3, 4, 5, 11, 14, 18, 19, 20, 21, 22, 23, 24, 25	CFA
USA	Kinsey et al. 2014	3005 Com	1 (10)	6, 7, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 23, 24, 25	EFA
Japan	Kaneko and Honjo 2014	1786 Com	1 (16)	3, 4, 6, 9, 17, 18, 20, 23, 24	EFA
Japan	Suetsugu et al. 2015	244 Com	4 (14)	1, 3, 5, 6, 11, 17, 18, 22, 23, 24, 25	EFA
Spain	Garcia-Esteve et al. 2016	840 Com/Cli	4 (25)	None	CFA and EFA
Japan	Ohashi et al. 2016	392 Com	3 (25)	None	EFA and CFA
Italy	Busonera et al. 2017	123 Com	3 (25)	None	PCA
India	Vengadavaradan et al. 2019	250 Com	5 (19)	6, 8, 9, 15, 16, 21	EFA

* Com - Community samples / Cli – Clinical samples

** Original authors of the instrument

Brockington et al. (2006) was not included because no further factor analysis was performed in their study

PCA principal component analysis, *CFA* confirmatory factor analysis, *EFA* exploratory factor analysis

In view of so many different models, Ghahremani et al. (2019) conducted a systematic review of the factor structures (dimensionality) of the PBQ. The authors concluded that the original English version of the questionnaire was not confirmed for Japanese, Italian, Spanish or other English versions included in the review. Thus, the PBQ does not seem to be universally applicable in terms of factor structure, indicating the need for specific studies for each population. To reinforce this scenario, a brief comparison of the factor solution adopted in adaptation studies of the PBQ worldwide is shown in Table 1. In fact, this wide diversity of factor solutions can be considered to be a result of the different cultural and psychosocial factors affecting mother-infant relationships. Therefore, cross-cultural testing and norming are very important in order to make PBQ suitable in all of these settings. However, despite its great factorial diversity, Wittkowski et al. (2020) conducted a systematic review of parent-report assessment measures and concluded that the original or modified versions of the PBQ collectively received the strongest psychometric evaluation ratings with high quality of evidence.

Psychological conditions such as stress, depression and anxiety are also predictors of mental health problems and, together, may affect the quality of the mother-infant relationship during childhood and throughout life (Fisher et al., 2012). The main mechanism underlying this process seems to be related to a decrease in the quality of interaction with the baby since depressed mothers are more likely to have a difficult time adjusting to motherhood, are less sensitive to the demands of their infants, and have reduced face-to-face interactions and frequencies of positive facial expressions (Bernard et al., 2018).

Specifically, several studies have demonstrated the negative effects of maternal depression on the mother-infant relationship. Moehler et al. (2006), Dubber et al. (2015), Kerstis et al. (2016), Nonnenmacher et al. (2016), and Dib et al. (2019) concluded that maternal depressive symptoms were associated with a lower quality of maternal bonding to the infant. In addition, mothers with depression were significantly less sensitive, were more disengaged, showed less positive affect, and were at higher risk for the developing mother-infant relationship.

Since depression is consistently related to parent-child interaction, it was chosen in the present study as a tool for assessing validity based on the relations to other variables. Specifically, we employed the Edinburgh Postnatal Depression Scale (EPDS), one of the instruments most extensively used to screen for postnatal depression in community samples. Indeed, the EPDS has been used as a validity measure in several PBQ adaptation studies (Edhborg et al., 2011; Garcia-Esteve et al., 2016; Kaneko & Honjo, 2014; Kinsey et al., 2014; Moehler et al., 2006; Ohashi et al., 2016; Örün et al., 2013; Reck et al., 2006; Siu et al., 2010; Suetsugu et al., 2015; van Bussel et al., 2010; Vengadavaradan et al., 2019; Wittkowski et al., 2010).

Within this context, the objective of the present study was to investigate validity evidence from the Brazilian version of the Postpartum Bonding Questionnaire (PBQ-Br)

based on its internal structure (dimensionality, reliability, and measurement invariance) and on its relations to other variables (depression, in our case). Thus, it was hypothesized that: (1) the original PBQ dimensionality (Brockington et al., 2001) does not show adequate fit to the Brazilian data; (2) the PBQ-Br holds measurement invariance between mothers with and without depression symptoms; (3) the PBQ-Br shows validity evidence based on the relation to depression symptoms (validity evidence based on the relation to other variables, more specifically convergent evidence), i.e., a positive and moderate to strong relationship with depressive symptoms.

Method

Participants

The present study is part of the Ribeirão Preto and São Luís Brazilian Cohort Studies (BRISA in the Portuguese acronym), which aimed to investigate the etiological factors of preterm birth and the consequences of perinatal factors for child health in the cities of Ribeirão Preto and São Luís (Da Silva et al., 2014). This is a cross-sectional study that used information from the BRISA follow-up stage (beginning of the second year of life), from February 2011 to September 2013, in Ribeirão Preto (state of São Paulo) and São Luís (state of Maranhão), including mothers from community samples. Data for the PBQ were available for 1069 mothers from Ribeirão Preto and 1138 mothers from São Luís, representing a convenience sample of 2207 mothers.

Regarding family and socioeconomic characteristics of the mothers who participated in this study (Table 2), the mean age of the mothers at the time of the PBQ interview was 25.9 years and the mean age of the child was 1.6 years (19.2 months), which was higher than in most studies that used the PBQ. There was a similar proportion of the child's gender and the majority of mothers were married or in a consensual union, belonged to disadvantaged socioeconomic classes, had 9 to 11 years of schooling, and were non-white.

Table 2 Socioeconomic and family characteristics of the study sample ($n = 2{,}207$)

Sociodemographic variables	Mean (*SD*) or *N* [%]
Maternal age (years)	25.9 (5.8)
Child age (years)	1.6 (0.4)
Sample city	
Ribeirão Preto	1069 [48.4]
São Luís	1138 [51.6]
Child gender	
Male	1094 [49.6]
Female	1113 [50.4]
Mother ethnicity	
White	748 [33.9]
Other	1459 [66.1]
Maternal marital status	
Married or in consensual union	1762 [79.8]
No companion	445 [20.2]
Economic status	
Most favored economic classes	548 [24.8]
Disadvantaged economic classes	1659 [75.2]
Maternal education	
0–8 years of study	417 [19.0]
9–11 years of study	1555 [71.0]
≥12 years of study	218 [10.0]

The number of participants may vary for each category

Procedures

Written informed consent was obtained from all participating mothers and the Ethics Committee of the University Hospitals of Ribeirão Preto and São Luís (process numbers 11157/2008 and 3980/2010 respectively) approved the study.

The BRISA study took place in three stages. The first stage corresponded to prenatal care, when all pregnant women who had received prenatal visits up to the 5th month of pregnancy (between 22 and 25 weeks) at hospitals and health units in Ribeirão Preto ($n = 1400$) and São Luís ($n = 1447$) were invited to come later to the University Hospital of Ribeirão Preto and to the University Hospital Mother-Child Unit in São Luís to complete forms and data information. In the second stage, related to the estimated time of birth, all maternities in Ribeirão Preto and São Luís were monitored in the search for babies born to women contacted during the prenatal stage. In this second stage (birth) 1370 women were interviewed in Ribeirão Preto and 1380 in São Luís, representing an acceptance rate of 97.8% and 95.3%, respectively. Losses in this stage were due to the non-location of mothers in maternity wards, abortion, and refusals to participate. In the third stage, corresponding to follow-up (second year of life of the babies), all mothers and their babies were invited again to participate in the investigation for further assessment, including socioeconomic data, mother-infant relationship and depression assessment. A total of 2207 mothers out of the 2847 mothers of the baseline sample (prenatal) were re-evaluated in this follow-up ($n = 1069$ in Ribeirão Preto and $n = 1138$ in São Luís), representing an acceptance rate of 76.3% and 78.6%, respectively, compared to the baseline sample. Losses in this stage were due to refusal to participate and non-location of mothers. All questionnaires were

filled out by the mothers themselves, with help provided by research assistants whenever necessary.

There was no significant differences between the baseline sample ($n = 2847$) and the missing sample regarding maternal age, marital status, maternal education, or socioeconomic status. However, the missing sample was composed of a higher proportion of non-white mothers ($p = 0.006$).

Measures

Postpartum bonding questionnaire—PBQ (Brockington et al., 2001)

This is a self-report questionnaire used to assess the mother-infant relationship based on a six-point scale ("always", "very often", "quite often", "sometimes", "rarely", and "never"). The original PBQ has 25 items organized into a four-factor model. The factors reflect impaired bonding (factor one with 12 items representing sentences such as "I feel close to my baby", "My baby winds me up", "My baby cries too much", "My baby irritates me"), rejection and anger (factor two with seven items such as "I regret having this baby", "I feel angry with my baby", "My baby annoys me"), anxiety about care (factor three with four items such as "My baby makes me feel anxious", "I am afraid of my baby"), and incipient abuse (factor four with two items such as "I have done harmful things to my baby" and "I feel like hurting my baby"). Positive responses, such as "I enjoy playing with my baby", are scored from 0 (always) to 5 (never). Negative responses, such as "I feel angry with my baby", are scored from 5 (always) to 0 (never), with high scores indicating a more problematic mother-infant relationship. Thus, PBQ is scored as the overall sum of all items.

Permission to develop the Brazilian version of the PBQ was given by the main author of the instrument. The PBQ was translated into Brazilian Portuguese according to the Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures (Beaton et al., 2000). In general, two native English speakers proficient in Brazilian Portuguese translated the English version into Brazilian Portuguese so that two written reports were produced. In the second stage, the translators resolved any discrepancies and synthesized the reports into one version. Next (stage three), another native English speaker proficient in Brazilian Portuguese back-translated the Brazilian version into English while blinded to the original English version. In stage four, linguistic adjustments and minor changes in some terms and expressions were performed in order to improve the quality of the translation and to reach consensus about discrepancies. In the last stage, 20 individuals of the community sample were pretested to check the understanding of the item.

Edinburgh Postnatal Depression Scale – EPDS (Cox et al., 1987)

EPDS is a self-administered 10-item scale used to investigate symptoms of postpartum depression in the follow-up stage. Each item is scored on a four-point scale (from 0 to 3). The total score ranges from 0 to 30, where higher scores indicate more symptoms of depression. Santos et al. (2007) originally investigated validity evidence for Brazil and a more recent adaptation study was also conducted by Figueiredo et al. (2015) in one of the cities of the present study (Ribeirão Preto), which suggested several cutoff points according to different specificity and sensitivity values. In the present study, a cutoff point of ≥12 was adopted to indicate the presence of depression symptoms (sensitivity of 75.6%, specificity of 86.2%, and positive predictive value of 81.9%). Cronbach's alpha coefficient in the study by Figueiredo et al. (2015) was 0.86.

Sociodemographic data

All mothers completed a structured questionnaire containing information about socioeconomic and family characteristics (i.e., mother's and child's age, mother's ethnicity, child's gender, maternal marital status, and maternal educational level and socioeconomic status, calculated according to a structured Brazilian questionnaire that estimates the purchasing power of families).

Data Analyses

The R (R Core Team, 2019) and RStudio (RStudio Team, 2019) tools were used to perform all statistical analyses. Descriptive statistics were obtained with the *skimr* package (McNamara et al., 2018), the coefficient of variation (CV) was calculated using the *sjstats* package (Lüdecke, 2019), the standard error of the mean (SEM) was estimated with the *plotrix* package (Lemon, 2006), and the mode was calculated with the *DescTools* package (Signorell et al., 2019). Severe univariate normality violations were considered for absolute values of skewness > 3 and kurtosis > 7 (Finney & DiStefano, 2013; Kline, 2016).

Confirmatory factor analysis (CFA) was performed to verify if the original four-factor structure proposed by Brockington et al. (2001) showed adequate fit to the Brazilian sample (step 1). The *lavaan* package (Rosseel 2012) was employed to conduct CFA using the weighted least squares means and variance (WLSMV) estimation method (Muthén, 1983). As goodness-of-fit indices, we used the normed fit index (NFI), Tucker-Lewis index (TLI), comparative fit index (CFI), the root mean square error of approximation (RMSEA), chi-square/degrees of freedom ratio (χ^2/df), and the standardized root mean square residual

(SRMR). As rules of thumb, $\chi^2/df < 5$, CFI, NFI and TLI > 0.95, SRMR < 0.08, and RMSEA < 0.08 are indicators of a good model fit (Boomsma, 2000; Byrne 2016; McDonald & Ho, 2002).

The *minDiff* package was used to conduct the random division of the data (Papenberg, 2018). Mother's age was used as the criterion variable, permitting a reduction of differences among subgroups. To generate such subgroups, 1000 repetitions were used in order to minimize differences between subgroups. The less different group assignment was selected, i.e., of two independent and similar subgroups, one was used as the calibration subsample and the other as the validation subsample (Chin & Todd, 1995). Thus, in the first subsample we performed exploratory factor analysis (EFA; step 2) and in the other subsample we performed another EFA (step 3) of the solution found in the EFA described in step 2 using the same goodness-of-fit indices previously mentioned. We also performed another CFA in the second subsample to test the new proposed structure (step 3).

Regarding EFA, the Kaiser-Meyer-Olkin (KMO) coefficient was used as a measure of sampling adequacy and the Bartlett's test was chosen to determine if the matrix of correlations was factorable (i.e., the correlations differ from 0) (Revelle, 2019). KMO values > 0.8 and Bartlett's test significance ≤0.05 indicate adequate sampling (Marôco 2018). The number of factors was determined by the data comparison approach as suggested by Ruscio and Roche (2012) using the *RGenData* package (Ruscio, 2018). The factor was extracted using a weighted least squares factoring method and the ρ_{PC} matrix and the oblimin transformation rotation was applied. The cutoff for loading items was 0.50. The Bartlett's test, the extraction of the KMO coefficient factors and the ρ_{PC} were carried out using the *psych* package (Revelle, 2019). The reliability of the scores regarding internal consistency was assessed using the *semTools* package (Jorgensen et al., 2019). The estimates used were $\omega_{ordinal}$ (Raykov, 2001) and $\alpha_{ordinal}$ (Oliden & Zumbo, 2008), where higher values were assumed to indicate better evidence in terms of internal consistency.

Measurement invariance was assessed using the *semTools* package (Jorgensen et al., 2019). Theta-parameterization was used as an approach to the categorical nature of the items (Millsap & Yun-Tein, 2004) and a group of four nested models were compared (configural invariance, factor loadings, thresholds, and latent means). The latent mean PBQ-Br variables were compared and Cohen's *d* was used as effect size (Cohen, 1988). The standard deviations, score percentiles and raw means were calculated with the *doBy* package (Højsgaard & Halekoh, 2018).

To provide further evidence of PBQ-Br validity (validity evidence based on relations to other variables), depressive symptoms and the mother-infant relationship were investigated using Welch ANOVA for two independent samples. We also calculated the mean and standard deviation of PBQ-Br scores separately for groups with and without depression symptoms. The ω^2 was used as an effect size measure (Hays, 1963). Homoscedasticity was evaluated by the Levene test using the *car* package (Fox & Weisberg, 2019). The Pearson correlation between PBQ-Br and depressive symptoms (EPDS) was also calculated.

Results

Validity Evidence based on the Internal Structure

Several steps were carried out to analyze the validity evidence based on the internal structure of the PBQ-Br, as described below: dimensionality, reliability, and measurement invariance.

Dimensionality: Confirmatory Factor Analysis of the Original Structure of the PBQ

A CFA was conducted for the initial assessment of the psychometric properties of the PBQ-Br by comparing the overall goodness-of-fit indices to those of the original model of Brockington et al. (2001), with 25 items organized into four factors. Based on the goodness-of-fit indices (χ^2 = 3,003.803; $df = 269$; $\chi^2/df = 11.167$; $CFI = 0.812$; $TLI = 0.798$; $NFI = 0.798$; $RMSEA = 0.069$; $SRMR = 0.105$), the original model did not show satisfactory indexes, leading us to decide for the use of an EFA.

Distributional Properties of the Items

Since we were unable to confirm the four-factor structure of the original PBQ model, the distributional properties of the items were investigated. Summary measures, skewness, kurtosis, and a histogram for each of the 25 items were used to judge the distributional properties and psychometric sensitivity of the Brazilian sample (Table 3).

As can be observed in Table 3, several items had skewness and kurtosis values above acceptable levels, revealing serious problems of univariate normality. The chosen estimator (i.e., WLSMV) does not require multivariate normality as an assumption; however, it requires bivariate normality for the ρ_{PC}. The algorithm of the ρ_{PC} estimates the thresholds using the inverse of the normal distribution from the frequency of the categories and the correlation between them from the quantiles of normal distribution - which clearly the items do not fit to. In this case, the estimates of ρ_{PC} would be artifactual since they

Table 3 Descriptive statistics of items ($n = 2207$)

Item	*M*	*SD*	*Min*	*Max*	Histogram	*Mode*	SEM	*CV*	*Sk*	*Ku*	% missing
Item 1	0.36	0.80	0	5		0	0.02	2.21	2.53	6.58	0.00
Item 2^R	0.55	1.01	0	5		0	0.02	1.83	2.20	5.35	0.05
Item 3^R	0.44	0.90	0	5		0	0.02	2.06	2.45	6.70	0.00
Item 4	0.32	0.79	0	5		0	0.02	2.50	3.30	12.86	0.23
Item 5^R	0.12	0.55	0	5		0	0.01	4.74	6.16	43.23	0.05
Item 6^R	0.18	0.82	0	5		0	0.02	4.53	4.99	24.74	0.27
Item 7^R	1.02	1.29	0	5		0	0.03	1.26	1.41	1.74	0.09
Item 8	0.21	0.74	0	5		0	0.02	3.49	4.56	22.90	0.00
Item 9	0.12	0.51	0	5		0	0.01	4.35	5.97	43.36	0.09
Item 10^R	0.84	1.11	0	5		0	0.02	1.32	1.49	2.39	0.18
Item 11	0.46	0.91	0	5		0	0.02	1.98	2.25	5.09	0.36
Item 12^R	1.52	1.07	0	5		2	0.02	0.70	0.86	1.46	0.23
Item 13^R	0.65	1.04	0	5		0	0.02	1.61	1.89	3.95	0.14
Item 14^R	0.59	0.87	0	5		0	0.02	1.48	1.61	3.08	0.00
Item 15^R	0.05	0.39	0	5		0	0.01	7.26	9.52	103.71	0.09
Item 16	0.23	0.82	0	5		0	0.02	3.61	4.41	20.30	0.18
Item 17^R	0.04	0.38	0	5		0	0.01	9.22	10.59	119.62	0.14
Item 18^R	0.08	0.43	0	5		0	0.01	5.45	7.26	62.77	0.05
Item 19^R	1.07	1.31	0	5		0	0.03	1.23	1.36	1.52	0.05
Item 20^R	0.08	0.45	0	5		0	0.01	5.91	7.59	66.70	0.23
Item 21^R	0.61	0.88	0	5		0	0.02	1.45	1.37	1.72	0.18
Item 22	0.35	0.93	0	5		0	0.02	2.65	3.29	11.33	0.27
Item 23^R	0.24	0.77	0	5		0	0.02	3.17	4.00	17.98	0.00
Item 24^R	0.02	0.24	0	5		0	0.01	11.40	14.15	231.41	0.00
Item 25	0.95	1.34	0	5		0	0.03	1.42	1.17	0.18	0.00

^{R} - Reverse items, *SEM* standard error of the mean, *CV* coefficient of variation, *Sk* skewness, *Ku* kurtosis

would ignore the absence of psychometric sensitivity of the items and lead to unrealistic conclusions about factor validity evidence. A scale consisting of items without psychometric sensitivity cannot exhibit validity evidence (Marôco, 2014). The inadequacy of weighted least squares methods with ρ_{PC} matrices has been reported, namely in conditions of severe violation of the assumption of bivariate normality, as can be observed in 13 of the 25 items of the PBQ. Thus, those items were removed from the analysis (i.e., items 4, 5, 6, 8, 9, 15, 16, 17, 18, 20, 22, 23, and 24). Finney et al. (2016) recommends the use of both maximum likelihood estimation with robust (Huber–White) standard errors and diagonal weighted least squares methods (as the WLSMV estimator) for categorical items with six or more points.

Exploratory Factor Analysis of PBQ-Br

After performing the CFA (described above in the dimensionality results), we randomly split our data into two subsamples. In the first one we performed an EFA and in the second we performed a CFA using the results of the solution found in the EFA performed in the first subsample. The data obtained met the KMO coefficient (0.839) and Bartlett's test of sphericity ($p < 0.001$). The results of the EFA performed in the first subsample revealed a one-factor solution including 12 items as the best factor structure, in which eight items with loadings above 0.50 (i.e., items 2, 7, 10, 11, 13, 14, 19, and 21) explained 32.8% of the variance (Table 4). A new EFA, performed in the second subsample, which contained only the eight items with factor loadings above 0.50, revealed 38.7% of explained variance (RMSR = 0.04; TLI = 0.912; RMSEA = 0.082; [90% CI: 0.071, 0.094]). Based on these results, the one-factor solution was adopted for the PBQ-Br.

To test the new proposed structure (one factor with eight items), we also performed a CFA in the second subsample. The goodness-of-fit indices were $\chi^{2(20)} = 91.977$, $\chi^2/df = 4.599$, $CFI = 0.979$, $NFI = 0.973$, $TLI = 0.970$, $SRMR = 0.038$, $RMSEA = 0.057$, and $P(\text{rmsea} \leq 0.05) = 0.140$, [90% CI: 0.046, 0.070], revealing good fit to the data.

Reliability of the Scores: Internal Consistency

Regarding internal consistency, the α_{ordinal} was 0.83 and the ω_{ordinal} was 0.78, indicating good reliability of the scores.

Table 4 Factor loadings of the one-factor solution of the Brazilian version of the Postpartum Bonding Questionnaire, obtained through EFA

PBQ Items	Factor 1
Item 1	0.500
Item 2[R]	**0.537**
Item 3	0.494
Item 7[R]	**0.611**
Item 10[R]	**0.611**
Item 11	**0.510**
Item 12[R]	0.453
Item 13[R]	**0.711**
Item 14[R]	**0.709**
Item 19[R]	**0.530**
Item 21[R]	**0.746**
Item 25	0.440
Total of variance	0.328

[R] - Reverse Items

Factor loadings > 0.500 are in bold

Table 5 PBQ-Br measurement invariance among mothers with and without depressive symptoms

Model	χ^2	*df*	χ^2/df	$\Delta\chi^2$	*CFI*	ΔCFI
Configural	73.939	40	1.85	–	0.976	–
Metric	81.185	47	1.73	9.136*	0.976	0.000
Scalar	113.652	78	1.46	35.848*	0.978	0.002
Latent means	515.256	79	6.52	93.553**	0.832	0.146

*$p < 0.05$, **$p < 0.001$

EPDS Edinburgh Postnatal Depression Scale

With depressive symptoms (EPDS ≥ 12 points) vs. without depressive symptoms (EPDS < 12)

Measurement Invariance across Mothers with and without Depressive Symptoms

Using the EPDS we separately calculated the mean and standard deviation (*SD*) of PBQ-Br scores for groups without depression symptoms (EPDS < 12) and with probable depression symptoms (EPDS ≥ 12). The number of mothers in the second group was 444. Thus, a random subsample ($n = 436$) of similar size was extracted from the first group of mothers. The proposed version showed scalar measurement invariance between mothers with and without depressive symptoms for both criteria (i.e., $\Delta CFI \leq 0.01$ and $\Delta\chi^2$), thus permitting us to establish comparisons of PBQ scores between groups (Table 5). The latent means differed significantly ($\Delta\chi^2 = 93.553$; $\Delta df = 1$, $d = 0.822$).

Validity Evidence Based on the Relations to Other Variables

For the associations between the PBQ-Br and the EPDS we separately calculated the mean and standard deviation (SD) of PBQ-Br scores for groups without depression symptoms (EPDS < 12; $n = 1{,}732$) and with probable depression symptoms (EPDS ≥ 12; $n = 441$). The mean PBQ-Br score was 4.99 ($SD = 4.36$) for the non-depressed group and 9.01 ($SD = 6.24$) for the depressed group. Since the samples did not show homoscedasticity ($W^{(1;2,174)} = 73.678$; $p \leq 0.001$), Welch's ANOVA was applied to the data. The mean score for the depressed mothers were significantly higher than that for mothers with no symptoms of depression ($F_{Welch}^{(1;558.88)} = 163.98$; $p < 0.001$; $\omega^2 = 0.070$; ω^2 [95% CI: 0.03, 0.11]). Pearson's correlation between PBQ-Br and EPDS scores was $r = 0.426$ ($p < 0.001$). The total mean PBQ-Br score was 5.79 ($SD = 5.07$).

Finally, the Brazilian version of the PBQ is presented in Table 6, with the original English items and the respective Brazilian translation.

Discussion

In this study we investigated the psychometric properties of the PBQ-Br in a large community sample of two Brazilian cities. A shortened one-factor solution with eight items was suggested as the best factor structure. Generally, we found good validity evidence and the PBQ-Br proved to be a useful tool for assessing the mother-infant relationship in this population.

As mentioned, the original PBQ model (Brockington et al., 2001) has 25 items organized into four factors. However, this factor structure does not appear to be the most suitable since other adaptation studies have resulted in different models. A comparison of the factor solution (dimensionality) adopted in the PBQ adaptation studies presented in Table 1 shows that studies testing the psychometric properties of the instrument across countries reported different factor structures. One of the main reasons for this variety of factorial models is related to the different cultural and psychosocial backgrounds affecting mother-infant relationships, a fact that strongly suggests the need for adaptation of the PBQ to specific populations (lack of transcultural invariance).

Comparing the factor structure presented here to that of the original instrument, we found a different solution. Seven of the eight items included in the Brazilian version correspond to Factors 1 and 2 of the original Brockington version (related to impaired bonding and rejection/anger) and only one item corresponds to Brockington's Factor 3, related to infant-focused anxiety. None of the items of the original Factor 4 ("I feel like hurting my baby" and "I have

Table 6 The brazilian version of the postpartum bonding questionnaire (PBQ-Br)

Original item n°	Original Factor	Scoring	PBQ-Br items(English version / Brazilian Portuguese version)
2	1	5 → 0	I wish the old days when I had no baby would come back/ Gostaria de voltar ao tempo em que ainda não tinha este bebê
7	1	5 → 0	My baby winds me up/Meu bebê me enerva
10	1	5 → 0	My baby irritates me/O meu bebê me deixa desesperada
11	2	0 → 5	I enjoy playing with my baby/Gosto muito de brincar com o meu bebê
13	1	5 → 0	I feel trapped as a mother/Sinto-me encurralada como mãe
14	2	5 → 0	I feel angry with my baby/Sinto-me zangada com o meu bebê
19	3	5 → 0	My baby makes me anxious/O meu bebê me deixa ansiosa
21	2	5 → 0	My baby annoys me/Meu bebê me irrita

*Original item number and original factor according to Brockington et al. (2001)

done harmful things to my baby"), associated with pathological behavior, reached meaningful loading in our EFA and these items were therefore eliminated from the PBQ-Br. Indeed, most studies have also removed these items from their factor solution (Kaneko & Honjo, 2014; Kinsey et al., 2014; Nazaré et al., 2012; Reck et al., 2006; Suetsugu et al., 2015; Wittkowski et al., 2010). Regarding these items, there are some social concerns about the kind of answers they represent, so that participants may tend to respond in a socially desirable manner. In addition, Brockington et al. (2006) also warned that it is unlikely that a self-report instrument can ever be adequate to explore such very sensitive matters and may not be effective in penetrating the defenses of these mothers. For these reasons, these items usually show low psycometric sensitivity and lack of diagnostic accuracy and some authors thus recommend omitting them.

Considering the items that remained in the Brazilian version of the PBQ, one question deserves to be discussed. The set of eight items seems to indicate much more routine issues of a mother-infant relationship than bonding disorders. In general, these eight items show feelings common to any newly formed mother-child relationship such as anxiety, irritation, anger, annoyance, regret, and happiness. Once again, the items that would most potentially evaluate mother-infant disorders were excluded because of their poor distributional properties. On this basis, we suggest that the PBQ-Br should be used mainly as an instrument to assess the mother-infant relationship rather than bonding disorders. Although the original version of the PBQ was designed to detect disorders of the mother-infant relationship, the results obtained in Brazil show that cultural and psychosocial specificities have led investigators to disregard certain items, resulting in changes in the primary purposes of the instrument. In other words, due to changes in the instrument's dimensionality (factor structure), much of the initial objective of the instrument should be reconsidered. Thus, it seems more reasonable, from both a clinical and a psychometric point of view, to recommend the use of PBQ-Br as a tool to assess routine issues of the mother-infant relationship, and we consider this result as a major contribution of our study. It is interesting to highlight that adaptation of the instrument from a psychometric point of view is not enough. The changes in the instrument's dimensionality must also be accompanied by adjustments in the meaning of the items in general, which can lead to a different understanding of the instrument's purpose, as occurred in the Brazilian version.

Regarding the percentage of total variance, the general factor of the PBQ-Br accounted for 38.7% of this variance, which can be considered acceptable. As we discussed before, the possible influence of response bias due to social desirability may affect the answers and may hinder or distort the evaluation of the mother-infant relationship. However, Kaneko and Honjo (2014) and Reck et al. (2006) found the percentage of total variance of their one-factor model to be lower than ours, i.e., 23.9% with 16 items in both cases. The other one-factor models (Kinsey et al., 2014; Nazaré et al., 2012) did not report their percentage of explained variance.

The reliability evidence (in terms of internal consistency) of the PBQ-Br was good (the $\alpha_{ordinal}$ was 0.83 and $\omega_{ordinal}$ was 0.78) and agrees with other adaptation studies that also proposed a one-factor solution, achieving values of 0.85 (Reck et al. 2006), 0.71 (Nazaré et al. 2012), 0.85 (Kinsey et al. 2014), and 0.67 (Kaneko and Honjo 2014). We consider this result to be particularly satisfactory since, as far as we know, no PBQ studies have been performed on mothers of "older" children (in our study, the mean age of the offspring when the PBQ was applied was 19.2 months). Although all adaptation studies were carried out with children within the first 6 months of life, the original study (Brockington et al. 2001) did not define any specific age limits for application; thus, there is no potential issue against the use of the instrument with older children. On the contrary, our study successfully

expanded the age limit for the application of the PBQ beyond the postpartum period, opening new avenues for its use in clinical practice and research.

We should also consider that the child's age can have an impact on the factorial structure of the PBQ, because reporting feelings and perceptions about parenting a newborn could be very different compared to parenting a nearly 2-year-old child. In this scenario, the age of the children could be a variable that helps explain why the Brazilian factorial structure differs from the original version.

A further argument in favor of using the PBQ at extended postpartum ages regards an epistemological consideration about the timing of maternal-infant bonding, as pointed out by Bicking Kinsey and Hupcey (2013). Most authors agree that maternal-infant bonding is a process built and acquired over an extended period of time (during the first years of life) and not only during a "sensitive period", such as the immediate postpartum period, in order to achieve proper bonding (Klier, 2006; Reay et al., 2011). From this conceptual perspective, the fact that the PBQ was applied to mothers whose children were 1 to 2 years of age on average is compatible with the theory that the process of bonding development occurs throughout the child's first years of life.

Regarding measurement invariance, the PBQ-Br revealed a scalar measurement (i.e., strong measurement invariance) between the group with depressive symptoms and the group without depressive symptoms. This finding allows us to establish direct comparisons of the scores obtained with the instrument across both groups. Measurement invariance is essential to establish such comparisons and proved to be a positive finding regarding this version of the instrument. We did not find any other study of PBQ versions that tested measurement invariance. Further studies to test the invariance of this instrument between mothers of children under and up to 2 years of age are recommended.

The investigation of the mother-infant relationship associated with depression, as a measure of validity related to other variables, revealed that the items of PBQ-Br and EPDS were moderately to highly correlated in our sample ($r = 0.426$). The mean PBQ-Br score was significantly higher in probably depressed mothers than in the group of non-depressed mothers, indicating that mothers with more symptoms of depression showed more problems in the mother-infant relationship, as also found in previous studies (Busonera et al., 2017; Garcia-Esteve et al., 2016; Kaneko and Honjo 2014; Kinsey et al., 2014; Ohashi et al., 2016; Reck et al., 2006; Suetsugu et al., 2015; Wittkowski et al., 2010). In a general way, these results highlight the importance of considering the level of depression in the mother-child interaction. However, it is important to mention that a disturbed mother-infant relationship does not necessarily imply depression. It is not surprising that a depressed mother would show a more negative evaluation of her relationship with her child, tending to believe that all her behaviors and emotions are negative (Reay et al., 2011). However, as mentioned earlier, this is not a rule. Although there is a consensus about a strong association between bonding impairment and maternal depression, the two factors are not necessarily correlated (Brockington, 2004). From this perspective, impaired mother-infant bonding and maternal depression could represent two distinctive constructs and should be both analyzed in a complementary way.

A last point to consider is related to the social and economic characteristics of the Brazilian sample, since most of the mothers assessed had unfavorable socioeconomic indicators. Cooper et al. (2009) argued that the capacity of parents to provide the kind of care that promotes bonding in infancy can be severely compromised in adverse conditions such as poverty, particularly when mothers have depression. That idea was also addressed in two other studies conducted with a population of rural Bangladesh (Edhborg et al., 2011) and with mothers of São Luís (the same city as investigated in the present study), considered to be a poor Brazilian city (Rodriguez et al., 2011). The authors suggested that socioeconomic characteristics may be related to the quality of bonding, a result that should be further investigated. In the study by Kinsey et al. (2014), psychosocial variables were correlated with maternal-infant bonding and the results revealed a "socioeconomic bias", in which women who were older, more educated, not living in poverty, and married reported lower bonding scores. Thus, the wide diversity in the PBQ factor solutions found worldwide suggests that the construct of the mother-infant relationship is highly influenced by the cultural context, indicating an essential need to conduct more reliable studies on specific populations, especially in low- and middle-income countries.

The present study has some limitations. First, we did not perform a clinical interview for the assessment of mother-infant bonding, which prevented us from establishing cutoff scores for bonding disorders in the Brazilian population. In addition, it was not possible to correlate the PBQ with any other bonding measure since no such measures have been validated for Brazil. The closest we could get was the measure of depression assessed by EPDS, which does not assess bonding, although a vast literature describes these measures as highly correlated. Second, our sample is not representative of Brazil as a whole and our recruitment depended on voluntary participation. This could introduce a selection bias given that the participants in this study were more likely to belong to underprivileged socioeconomic classes. Although our sample size was large, generalization of the results should be done with caution, especially because our sample was from the

community (not clinical). The loss of variance of items might be more common in this sample, in which educational levels are homogeneously low. Finally, there are some concerns about the reporting bias, which is difficult to prevent or estimate. It is plausible to consider that responses to the questionnaires were influenced by social desirability and that the participants may have been embarrassed or afraid to answer the questionnaire in a sincere manner.

In conclusion, the Brazilian version of the PBQ (one-factor model with eight items) provided a measure with good validity evidence for the Brazilian population. However, this instrument is more suitable for assessing the mother-infant relationship in general rather than bonding disorders. Currently there are no normative measures of the mother-child relationship in Brazil and the present study would thus provide a much needed tool for Brazilian clinicians. It is important to remember that PBQ-Br is a screening tool and a high score on the shorter 8-item version might be indicative of the need for a larger investigation involving other assessments and variables.

In this scenario, we hope to contribute to the improvement of maternal mental health by providing adequate psychological support for the mother-child dyad during the first years of life. Subsequently, we suggest that our results be duplicated in other Brazilian samples and that further studies be conducted to investigate the association of problems in the mother-infant relationship with sociodemographic variables.

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Conflict of Interest The authors declare no competing interests.

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