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Factor Structure and Measurement Invariance of the Japanese Version of the Mother-to-Infant Bonding Scale

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Abstract

Background: Bonding disorders affect the growth and development of infants. In Japan, the Japanese version of the Mother-to-Infant Bonding Scale (MIBS-J) is widely used for early detection of bonding disorders. Repeated use of a questionnaire has problems of reduced validity. In order to correctly detect bonding disorders at multiple time points, it is necessary to confirm the measurement invariance of the scale. Baba *et al.* reported that invariance of the MIBS-J factor structure could only be obtained by abridging the scale into three items. **Purpose:** The aim of this study was to 1) confirm the factor structure and measurement invariance of the MIBS-J between two measurement times and 2) to examine factors that can be used without being affected by measurement time in order to identify item that contribute to measure met invariance. **Methods:** We analysed the data of 1049 and 878 mothers with a neonate collected in two waves: 5 days (Wave 1) and 1 month postpartum (Wave 2). Exploratory and confirmatory factor analyses were conducted on the data randomly divided into two groups in each wave. **Results:** The three-item model (MIBS-J items 1, 6, and 8) was most accepted. Measurement invariance and structural invariance were confirmed in the model. This was consistent with Baba *et al.*'s model. **Conclusion:** The three MIBS-J items showed measurement invariance and structural invariance in Japanese mothers during 1 month postpartum.

Keywords

Bonding Disorders, Mother-to-Infant Bonding Scale, Factor Analysis, Measurement Invariance

1. Introduction

The emotional ties that a mother or father has with their own child is called bonding [1]. Postnatal bonding disorders adversely affect parenting behaviour and cause neonatal abuse [2] [3] [4]. Parents with bonding disorders are not affectionate or feel hostile towards their own child or want to attack him/her. Postnatal bonding disorders may give negative impact on the growth and development of infants [5] [6] [7]. Children of parents with bonding disorders are likely to show poor social-emotional development [8].

There have been several instruments to measure perinatal bonding. In their metanalysis, Wittkowski *et al.* [9] listed 17 original measures as well as 13 modified versions derived from them. They include, for example, Mother-to-Infant Bonding Scale (MIBS) [10], Maternal Attachment Inventory (MAI) [11], Postpartum Bonding Questionnaire (PBQ) [12], and Prenatal Attachment Inventory (PAI) [13]. However, according to systematic reviews of instruments measuring bonding [9] [14], few of them had adequate psychometric properties. It is of current importance to establish robust instruments that satisfy reliability and validity. The Japanese version of Mother-to-Infant Bonding Scale (MIBS-J) [15] has been used widely for detection of bonding disorders in Japan. Use of the MIBS-J is not without limitations. It is of note that some of the 10 MIBS-J items are highly skewed [15] [16]. If the items on the scale are skewed, it may not correctly detect mothers with problems. Moreover, considering the fact that the MIBS-J is often used repeatedly for the same mothers, there remains uncertainty about the instrument's measurement invariance. Repeated use of a questionnaire has problems of reduced validity [17] [18] [19] [20] [21]. For example, the means of a symptomatic instrument decrease as repeatedly measured and the differences between cases and normal controls become less clear. There may be little clinical significance in using all the 10 items.

The MIBS-J has been validated as a two-factor structure. There are two studies on the instrument's factor structure. Yoshida *et al.* [15] reported two factors: Lack of Affection and Anger and Rejection. Kitamura *et al.* [16] identified virtually the same factor structure. Kitamura and colleagues also found measurement invariance between mothers and fathers. There still remain further issues about psychometrics of the measurement invariance of the MIBS-J [22]. collected data on postpartum mothers and fathers on 5 days, 1 month, and 4 months postpartum by using MIBS-J and confirmed the validity of the MIBS-J items. A three-item structural model (items 1, 6, and 8) was supported. Configural invariance was confirmed in both fathers and mothers at three time points. Among mothers, metric invariance was founded. Among fathers, partial metric invariance was accepted.

Therefore, in this study, we reanalysed data from the postpartum depression study [23] to 1) confirm the factor structure and measurement invariance of the MIBS-J and 2) to examine factors that can be used without being affected by measurement time among a Japanese mother population.

2. Methods

2.1. Study Procedures and Participants

This study is a reanalysis of data from a two-wave (Wave 1 at 5 days and Wave 2 at 1 month after childbirth) questionnaire survey on postpartum depression [23] [24] [25] [26] [27] that was conducted between August 2001 and April 2002. We recruited women who gave birth at five antenatal hospitals in Okayama, Japan. No exclusion criteria were used other than women who lacked the capacity of understanding Japanese. Eligible for this study were 1530 women. Among them, 1200 (78%) women received the questionnaires, and 1049 (69%) and 878 (57%) women returned the questionnaire at Waves 1 and 2. These women's mean (SD) age was 28.7 (4.1) years.

2.2. Measurement

We used the MIBS-J as a scale to assess mother-infant bonding [15]. The MIBS-J comprises 10 items with a 4-point Likert scale. The higher the score, the stronger the negative feeling from the mother to the infant. A two-factor structure was prosed: Lack of Affect and Anger and Rejection [15] [16].

2.3. Data Analyses

The data were randomly divided into two groups in each wave. The first groups of Wave 1 (n = 525) and Wave 2 (n = 440) were used for exploratory factor analyses (EFAs). We calculated the skewness and kurtosis of all the MIBS-J items. When the skewness (>2.0) or kurtosis (>4.0) was high, we performed log transformation of the item scores. The Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests were examined in order to confirm the adequacy of sample size and non-zero correlations among items. For EFAs, we used maximum likelihood method with PROMAX rotation starting from one-factor structure followed by subsequent models with an increasing number of factors.

In order determine the best model among several ones at each wave, we compared the models in terms of confirmatory factor analyses (CFAs) of the factor models extracted by the EFA at Waves 1 and 2 using the second halved groups of Wave 1 (n = 524) and Wave 2 (n = 438). At each Wave, a single factor model was the most parsimonious. The nest model (e.g., a 2-factor model) was accepted only when there appeared a significant difference (at the expense of df) in χ^2 (CMIN) between the two models. The absolute values of the goodness-of-fit of factor structure models were examined by CMIN, comparative fit index (CFI), and root mean square error of approximation (RMSEA). A good fit was defined as CMIN/df < 2.0, CFI > 0.97, and RMSEA < 0.05. An accepted fit was defined as CMIN/df < 3.0, CFI > 0.95, and RMSEA < 0.08 [28].

Because the best fit models at the two waves differed in their item configuration (Day 5 model and Month 1 model) as well as we were interested in the fit of Baba *et al.*'s model [22], we paid attention to temporal stability of these factor models across the 2 measurement time points in terms of their measurement invariance (MI). MI was conducted in the following order: configural, measurement (metric, scalar, and residual) invariance, and structural (factor variance) invariance. If one step was rejected, the next steps were not performed. Starting from the configural invariance, the model of the next step was accepted only when: 1) there was no statistically significant increase of χ^2, 2) decrease of CFI less than 0.01, or 3) increase of RMSEA less than 0.01 [29] [30]. The latter two measures were used because χ^2 is affected by sample size and can reject measurement invariance excessively. All statistical analyses were conducted using the SPSS version 27.0 and Amos version 27.0.

2.4. Ethical Consideration

This study was approved by the Ethics Committee of Kumamoto University, School of Medical Sciences (No. 458). The study was performed in accordance with the Declaration of Helsinki.

3. Results

3.1. Factor Structure

In the first half of the sample, the items 4 and 6 showed high skewness and kurtosis (supplementary **Table 1** and **Table 2**). After log transformation of all the items, the items' skewness and kurtosis were improved. Hence, we included all items for the EFAs. At Wave 1, the KMO was 0.738, and Bartlett's sphericity test was χ^2 (df) = 1460.930 (45) ($p < 0.001$). The scree test indicated either two- or three-factor model (**Figure 1**). In the one-factor model, all the items, except items 2 and 4, showed factor loadings > 0.3 (**Table 1**). In the two-factor model, the first factor was loaded highly (>0.3) on items 3, 5, 7, and 9. The second factor was loaded highly on items 1, 6, 8, and 10. In the three-factor model, the second factor of the two-factor model was divided into two factors.

In order to determine the best fit one at Wave 1, we compared the EFA-derived models we performed CFAs using the second halved sample (**Table 2**). The decrease in χ^2 (df) was significant ($p < 0.001$) from the 1- to 2-factor models. This was also the case from 2- to 3-factor models but the decrease in χ^2 (df) was much smaller and improvement of CFI (from 0.925 to 0.934) and RMSEA (from 0.057 to 0.054) was trivial. Therefore, taking into consideration the principle of parsimony, we selected the two-factor model as the best to explain the Wave 1 data.

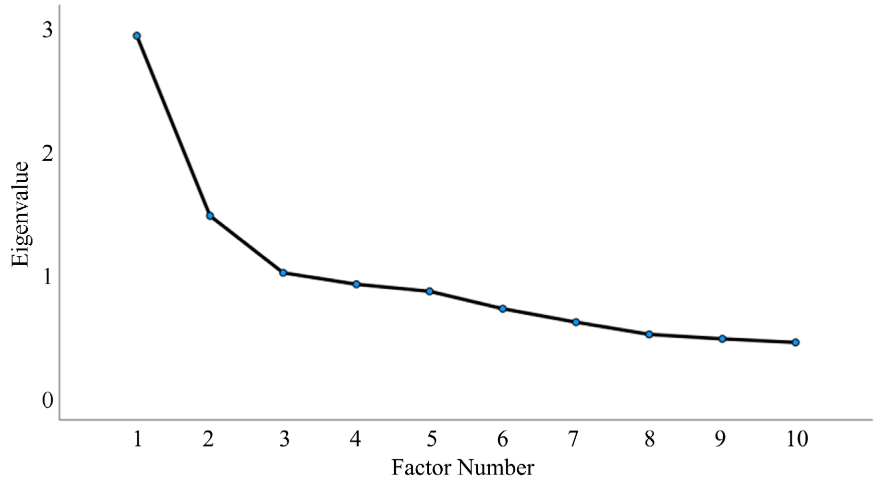

Figure 1. Scree plot of the MIBS-J items at Wave 1.

Table 1. Exploratory factor analysis of the MIBS-J items 5 days after childbirth.

No.	1-factor	2-factor		3-factor		
	I	I	II	I	II	III
1	0.68	0.20	0.67	0.19	0.69	−0.08
2	0.01	−0.09	0.11	−0.04	−0.05	0.80
3	0.69	0.80	0.07	0.80	0.06	−0.01
4	0.22	0.08	0.20	0.13	0.07	0.67
5	0.67	0.83	0.00	0.83	−0.00	−0.04
6	0.61	0.19	0.60	0.19	0.59	0.08
7	0.48	0.67	−0.08	0.67	−0.09	0.03
8	0.57	−0.04	0.77	−0.04	0.79	−0.06
9	0.36	0.41	0.03	0.42	0.01	0.13
10	0.38	−0.28	0.78	−0.28	0.77	0.08

Table 2. Comparison of MIBS-J factor structure models 5 days after childbirth.

Model	χ^2	*df*	χ^2/df	χ^2 (*df*)	CFI	ΔCFI	RMSEA	ΔRMSEA
1-factor	576.127	35	16.461	Ref	0.649	Ref	0.121	Ref
2-factor	149.862	34	4.408	426.265 (1)***	0.925	0.276	0.057	0.064
3-factor	135.413	33	4.103	14.449 (1)***	0.934	0.009	0.054	0.003

***p < 0.001; CFI, comparative fit index; RMSEA, root mean square error of approximation.

At Wave 2, the KMO was 0.770, and Bartlett's sphericity test was χ^2 (df) = 1546.734 (45) (p < 0.001) (**Table 3**). In the one-factor model, item 2 showed a low factor loading (0.20). The second factor was loaded highly on items 1, 6, 8, and 10. In the two-factor model, the first factor was loaded highly (>0.3) on items 1, 6, 8, and 10. The second factor was loaded highly on items 2, 3, 5, 7, and 9. In the three-factor model, the second factor of the two-factor model was divided into two factors.

The three-factor models of the MIBS-J at Wave 2, we performed CFAs using the second halved sample (**Table 4**). As in Wave 1, the 2-factor model was superior to the 1-factor model and so was the 3-factor model to the 2-factor model. However, the decrease in χ^2 (df) from the 2-factor to 3-factor models was much smaller than that from 1- to 2-factor models. Again, the improvement of CFI (from 0.899 to 0.896, worse) and RMSEA (from 0.070 to 0.072, worse) was not observed. Therefore, we selected the two-factor model as the best to explain the Wave 2 data.

It is of note that the 2-factor models at Waves 1 and 2 did not meet configural invariance and, in addition, the goodness-of-fit indices of the two-factor models at Waves 1 and 2 were both less than satisfactory (CFIs = 0.901 and 0.911 at Waves 1 and 2, respectively). Hence, we added Baba *et al.*'s model [22] and compared the three MIBS-J factor models in terms of measurement invariance.

3.2. Measurement Invariance

We evaluated MI of each model across the 2 observation time points (**Table 5**). Configural invariance was rejected in Day 5 (CFI = 0.901) and Month 1 models (CFI = 0.911). Baba *et al.*'s model [22] was accepted at configural and measurement invariance in the model. In structural invariance, factor variance invariance was accepted. As compared to the two EFA-derived models, Baba *et al.*'s model [22] was superior in temporal stability.

Table 3. Exploratory factor analysis of the MIBS-J items 1 month after childbirth.

No.	1-factor	2-factor		3-factor		
	I	I	II	I	II	III
1	0.69	0.78	0.01	0.76	0.06	−0.00
2	0.20	−0.20	0.53	−0.10	−0.18	0.73
3	0.58	0.12	0.67	0.17	0.07	0.70
4	0.40	0.24	0.27	0.08	0.73	−0.26
5	0.52	−0.02	0.74	−0.04	0.37	0.55
6	0.62	0.58	0.15	0.64	−0.15	0.31
7	0.42	−0.04	0.64	−0.14	0.65	0.22
8	0.66	0.81	−0.08	0.79	0.08	−0.12
9	0.46	0.18	0.43	0.07	0.60	0.02
10	0.65	0.81	−0.09	0.80	−0.01	−0.06

Table 4. Exploratory factor analysis of the MIBS-J items 1 month after childbirth.

Model	χ^2	*df*	χ^2/df	χ^2 (*df*)	CFI	ΔCFI	RMSEA	ΔRMSEA
1-factor	427.251	35	12.207	Ref	0.727	Ref	0.113	Ref
2-factor	179.326	34	5.274	247.925(1)***	0.899	0.172	0.070	0.043
3-factor	182.015	33	5.516	2.689(1)***	0.896	0.003	0.072	0.002

***p < 0.001; CFI, comparative fit index; RMSEA, root mean square error of approximation.

Table 5. Model comparison: measurement invariance between 5 days and 1 month after childbirth.

	χ^2	*df*	χ^2/df	χ^2 (*df*)	CFI	ΔCFI	RMSEA	ΔRMSEA	Judgement
Day 5 model									
Configural	361.928	68	5.322	Ref	0.901	Ref	0.047	Ref	Reject
Metric	397.314	76	5.228	35.386 (8)***	0.892	0.009	0.047	0	Reject
Month 1 model									
Configural	333.314	68	4.902	Ref	0.911	Ref	0.045	Ref	Reject
Metric	403.129	76	5.304	69.815 (8)***	0.890	0.021	0.047	0.002	Reject
Baba *et al.* (2023)									
Configural	0.000	0	0.000	Ref	1.000	Ref	-	Ref	Accept
Metric	3.578	2	1.789	3.578 (2)	0.998	0.002	0.020	0.020	Accept
Scalar	16.476	5	3.295	12.898 (3)	0.986	0.012	0.035	0.015	Accept
Residual	18.922	8	2.365	2.446 (3)	0.987	0.001	0.027	0.008	Accept
Factor variance	18.925	9	2.103	0.003 (1)	0.988	0.001	0.024	0.003	Accept

***p < 0.001; CFI, comparative fit index; RMSEA, root mean square error of approximation.

4. Discussion

The two-factor models (Day 5 and Month 1 models) showed the best goodness-of-fit at Waves 1 and 2. However, configural and metric invariances of these models were rejected. On the other hand, the single-factor model with three items (items 1, 6, and 8) that was proposed by Baba *et al.* [22] showed measurement and structural invariance at the two postpartum time points in our study. This is in line with Baba *et al.*'s study [22].

Why did most of the MIBS-J items prohibit measurement invariance? It may be that they are away from normal distribution and difficult to detect differences in maternal-baby bonding emotion. Item 8 ("I feel protective toward my child") that remined as one of the final items had skewness of 4.0 casting doubt about its normal distribution. A measure of maternal bonding towards a baby with items with low skewness is to be developed. In addition, they may be subject to influences from direct child-bearing environment. In this study, all the items which belong to Anger and Rejection failed to maintain measurement invariance. After discharge from the hospital, mothers face a different environment than they did in the hospital and the stresses associated with the physical and emotional changes. Anger and Rejection increases in 1 month postpartum due to environmental changes [31]. Bonding is worse with less social support [32] [33]. There is a link between bonding disorders, colic, and infant temperament [34] [35] [36]. Mothers whose child was hypersensitive showed negative feelings toward their children [34]. This suggests that Anger and Rejection is susceptible to environmental influences.

In recent years, there have been several reports on the cut-off point for the MIBS-J [26] [37]. Evaluation of MIBS-J total scores was more effective in 1 month postpartum than in day 5 postpartum [37]. However, since bonding changes over time [10] [15], it would be desirable to evaluate maternal bonding using items with established measurement invariance. In our study, measurement invariance was confirmed when the items were restricted to three items (items 1, 6, and 8), all of which belonged to Lack of Affect. Therefore, it is necessary to continuously evaluate maternal bonding using these three items for which measurement invariance was confirmed. In Japan, the MIBS-J is used in clinical practice along with the Edinburgh Postnatal Depression Scale during postpartum hospitalization, 2 weeks postpartum, and 1 month postpartum. Since the use of a large number of items is burdensome for mothers, it would be better to be able to assess them appropriately with smaller items in order to reduce the burden on mothers as much as possible.

Since the time when the data used in this analysis were collected, nearly two decades have passed. We should pay attention to whether social environments have changed around child bearing women. But Baba *et al.*'s data [22] were collected only a few years ago but they showed virtually the same results. Our replication study with a different population (one in Tokyo and another in Okayama) at different times supports robustness of Baba *et al.*'s report [22]. Clinicians should be alert to the need for social, psychological and physical support for mothers and fathers in order to prevent bonding disorders. Obviously, negative mother-to-infant emotions such as anger are important parts of maternal emotions but the MIBS-J items, our demonstrated, are not suitable measures for such emotions. In the future, it is necessary to consider how Anger and Rejection can be measured in a stable method.

This study has the following limitations. First, this study was conducted at two time points: day 5 and 1 month postpartum. It is necessary to confirm whether measurement invariance can be confirmed after 1 month postpartum. Second, cultural background should be taken into account. Both Baba *et al.* [22] and this study had Japanese samples. For generalization, we need to confirm whether similar results can be obtained for mothers from other cultures.

5. Conclusion

The three MIBS-J items showed measurement invariance and structural invariance in Japanese mothers during 1 month postpartum. All three items belonged to Lack of Affect. The number of MIBS-J items in clinical practice should be discussed in the future.

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Author Contributions

Conceptualization, F.Y., K.T. and T.K.; methodology, F.Y., K.T. and T.K.; investigation, F.Y., K.T.; data curation, M.Y. and T.K.; formal analysis, M.Y. and T.K.; writing—original draft preparation, M.Y. and Y.K.; writing—review and editing, M.Y., F.Y., K.T. and T.K.; visualization, M.Y. and T.K.; supervision, T.K. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The datasets generated during the current study are available from the corresponding author on reasonable request.

Ethics Approval Statement

This study was approved by the Ethics Committee of Kumamoto University, School of Medical Sciences (No.458).

Patient Consent Statement

Participants were all anonymous and were regarded as agreeing to participate by returning the questionnaire to the responsible researcher (TK) via postal service.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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