

Prenatal Attachment: Using Measurement Invariance to Test the Validity of Comparisons Across Eight Culturally Diverse Countries.

Abstract: 250 words

Main text: 3242 words

Sarah Foley¹

Claire Hughes¹

Aja Louise Murray²

Adriana Baban³

Asvini D. Fernando⁴

Bernadette Madrid⁵

Joseph Osafo⁶

Siham Sikander⁷

Fahad Abbasi⁷

Susan Walker⁸

Vo Van Thang⁹

Yen Luong Thanh Bảo⁹

Mark Tomlinson¹⁰⁻¹¹

Pasco Fearon¹²

Catherine L. Ward¹³

Sara Valdebenito¹⁴

Manuel Eisner¹⁴

¹Centre for Family Research, University of Cambridge, Cambridge, United Kingdom

²Department of Psychology, University of Edinburgh, Edinburgh, United Kingdom

³ Department of Psychology, Babes-Bolyai University, Cluj-Napoca, Romania

⁴ Department of Paediatrics, Faculty of Medicine, University of Kelaniya, Sri Lanka

⁵ Child Protection Unit, University of the Philippines, Manila, Philippines

⁶ Department of Psychology, University of Ghana, Legon, Accra, Ghana

⁷ Health Services Academy, Islamabad, Pakistan

⁸ Caribbean Institute for Health Research, The University of the West Indies, Kingston, Jamaica

⁹ Institute for Community Health Research, Faculty of Public Health, Hue University of Medicine and Pharmacy, Hue University, Hue, Vietnam

¹⁰Department of Psychology, Stellenbosch University, Stellenbosch, South African Institute for Life Course Health Research, Department of Global Health, Stellenbosch University, Cape Town, South Africa

¹¹School of Nursing and Midwifery, Queens University, Belfast, United Kingdom

¹² Research Department of Clinical, Educational and Health Psychology, University College London, London, United Kingdom

¹³Department of Psychology, University of Cape Town, Cape Town, South Africa

¹⁴Institute of Criminology, University of Cambridge, Cambridge, United Kingdom

Corresponding author: Sarah Foley

Email: sf412@cam.ac.uk; Tel: 01223 762841

Abstract

Purpose: Studies in high-income countries (HICs) have shown that variability in Maternal-Fetal Attachment (MFA) predict important maternal health and child outcomes. However, the validity of MFA ratings in low- and middle-income countries (LMICs) remains unknown. Addressing this gap, we assessed measurement invariance to test the conceptual equivalence of the Prenatal Attachment Inventory (PAI: Muller, 1993) across eight LMICs. Our aim was to determine whether the PAI yields similar information from pregnant women across different cultural contexts.

Methods: We administered the 18-item PAI to 1,181 mothers in the third trimester (Mean age = 28.27 years old, $SD = 5.81$ years, range = 18 – 48 years) expecting their first infant ($n = 359$) or a later-born infant ($n = 820$) as part of a prospective birth cohort study involving eight middle-income countries: Ghana, Jamaica, Pakistan, Philippines, Romania, South Africa, Sri Lanka and Vietnam. We used Multiple Group Confirmatory Factor Analyses to assess across-site measurement invariance.

Results: A single latent factor with partial measurement invariance was found across all sites except Pakistan. Group comparisons showed that mean levels of MFA were lowest for expectant mothers in Vietnam and highest for expectant mothers in Sri Lanka. MFA was higher in first-time mothers than in mothers expecting a later-born child.

Conclusion: The PAI yields similar information about MFA across culturally distinct middle-income countries. These findings strengthen confidence in the use of the tool across different settings; future studies should explore the use of the PAI as a screen for maternal behaviour that place children at risk.

Key words: maternal-fetal attachment; pregnancy; measurement invariance; lower-middle income; cross-cultural; parity

1 Prenatal Attachment: Using Measurement Invariance to Test the Validity of
2 Comparisons Across Eight Culturally Diverse Countries

3 Postpartum depression (PPD) is a key area of research in the field of maternal and
4 child health (Field, 2010), and research is increasingly recognising the crucial importance of
5 pregnancy as a period of potential risk and opportunity for intervention. However, research
6 on maternal psychological health has scarcely been conducted outside of high-income
7 countries (HICs) (known as the 10/90 gap; COHRED, 1990; Henrich, Heine & Norenzayan,
8 2010). That said, reviews that have focused on research in low- and middle-income countries
9 (LMICs) have demonstrate that prenatal stress is as strongly associated with adverse infant
10 outcomes as in HICs (Buffa et al, 2018; Parsons, Young, Rochat, Kringelbach & Stein, 2012)
11 and that rates of PPD often exceed those reported for HICs (e.g., Fisher et al, 2012; Woody et
12 al, 2017). Given this, it is critically important to test the universality of processes underlying
13 maternal and infant mental health in culturally and economically diverse contexts, as
14 outcomes differ crucially across contexts (Vidyasagar, 2006).

15 One area of focus, as illustrated in a recent systematic review (Tichelman et al, 2019),
16 has been the role of maternal-fetal attachment (MFA) – defined as the strength of mothers’
17 emotional ties with the fetus (and also known as prenatal bonding; Walsh, 2010). MFA
18 assessments capture variability in expectant mothers’ behaviours, cognitions and emotions
19 towards the fetus, which appear important for positive prenatal health practices such as
20 giving up smoking (e.g., Lindgren, 2001), attending clinics and exercising regularly (Cinar et
21 al, 2017). In a meta-analysis of 14 studies that both spanned prenatal and postnatal periods
22 and included direct observational ratings of parent-infant interactions, Foley and Hughes
23 (2018) found that MFA predicted caregiver sensitivity in interactions with their infant, which
24 is a potent influence on children’s cognitive and socio-emotional development (Mills-Koonce

25 et al, 2015). Thus, valid measurement of MFA has potentially far-reaching clinical
26 implications for the health of both mothers and infants (Laxton-Kane & Slade, 2002).

27 Predictors of MFA include gestational age (Yarcheski et al 2009), good maternal
28 mental health (Rollè et al, 2020), social support and first pregnancy (Tichelman et al, 2019).
29 In contrast, MFA appears unrelated to demographics (e.g., education, age, marital status),
30 fertility treatment, fetal defects or planned pregnancies (Tichelman et al, 2019). In a
31 systematic review of 41 studies, Rollè et al (2020) showed that treatment for depression can
32 improve MFA. However, this research field is limited by its narrow focus on parents (mainly
33 mothers) living in HICs (Brandon et al, 2009). For example, all but two of the 77 studies
34 included in Tichelman et al's (2019) review were from HICs.

35 Of the two MFA studies with LMIC samples included in Tichelman et al's (2019)
36 review, the first involved 672 mothers in rural Bangladesh. Edhborg and colleagues (2011)
37 found prenatal MFA (assessed via a translation of the widely-used Prenatal Attachment
38 Inventory; PAI: Muller, 1993) was positively associated with bonding when the infant was 2
39 – 3 months old and negatively associated with postnatal depressive symptoms. In the second
40 study Lingeswaran and Bindu (2012) assessed the feasibility of measuring MFA in India with
41 a sample of 230 pregnant women using the Maternal-Fetal Assessment Scale (MFAS;
42 Cranley, 1981). Their findings showed average MFA scores ($M = 87.43$, $SD = 10$) were at the
43 lower end of the range (minimum 70 – maximum 114), which the authors interpreted as
44 reflecting social and economic restrictions on women's ability to develop a relationship with
45 the fetus, coupled with a cultural emphasis upon birth rather than pregnancy. However,
46 another study in India (not included in Tichelman et al., 2019), found no association between
47 PAI scores and depression in gestational surrogates or matched controls (Lamba, Jadva,
48 Kadam and Golombok, 2018). Existing findings therefore paint a mixed picture regarding the
49 construct validity of the PAI in LMICs. Furthermore, in both the Bangladeshi and Indian

50 samples the Cronbach's alpha was lower than for English versions and included no further
51 psychometric analysis of the questionnaires.

52 Punamäki and colleagues (2017) asked 511 expectant Palestinian mothers living in
53 Gaza to complete the PAI. They reported that lack of social support mediated the association
54 between war trauma and reduced MFA, but found MFA was unrelated to PPD. Given the
55 scarcity of research on MFA in LMICs, it is difficult to judge whether this lack of association
56 reflects the particular challenges of living in a war zone, a more general contrast in the
57 salience of MFA across resource settings or cultural differences in the meaning or validity of
58 the instruments used (note Punamäki et al. were unable to replicate the established PAI factor
59 structure).

60 A key step in evaluating the conceptual equivalence of MFA ratings across different
61 contexts is to construct latent factor models and test for measurement invariance across
62 groups. That is, assessing whether a tool shows an equivalent structure and meaning across
63 distinct groups. Theoretically, assessing whether an instrument yields similar information in
64 different LMICs is necessary to test the cultural universality of inferences about specific
65 causal pathways. Practically, demonstrating across-site equivalence is useful in establishing
66 whether similar or distinct methods of identifying at-risk individuals should be used across
67 settings.

68 The current study first aimed to assess the conceptual and measurement equivalence
69 of the PAI across eight LMICs in widely different global regions. By testing for measurement
70 invariance across eight LMICs, we aim to establish whether PAI items capture variation in
71 how MFA is manifest across different groups. Finally, if measurement invariance is
72 established, our next two aims were to compare mean levels of MFA across site and birth
73 parity.

74 **Methods**

75 Participants

76 Trained female fieldworkers invited women attending antenatal appointments to
77 participate in the Evidence for Better Lives Study – Foundational Research (EBLS-FR), a
78 prospective birth cohort study in eight different sites ($N = 1208$) that represent distinct social
79 and cultural conditions across major world regions: Koforidua (Ghana, $n = 150$), Kingston
80 (Jamaica, $n = 152$), Tarlai Kalan (Pakistan, $n = 150$), Valenzuela (Philippines, $n = 154$), Cluj-
81 Napoca (Romania, $n = 150$), Ragama (Sri Lanka, $n = 152$), Worcester (South Africa, $n =$
82 150), and Hue (Vietnam, $n = 150$). Inclusion criteria were: i) third trimester of pregnancy
83 (i.e., weeks 29-40), ii) aged over 18, and iii) living primarily within the study's defined
84 geographical area. The average recruitment rate across sites was 82%. Table 1 presents
85 sample characteristics by site for the 1,181 women expecting singleton pregnancies in the
86 current study (excluding 27 multiple pregnancies). On average, mothers were 28.27 years
87 old, $SD = 5.81$ years, range: 18 – 48 years (note expectant mothers in Jamaica, Pakistan and
88 South Africa were significantly younger than mothers in Romania, Ghana, Sri Lanka and
89 Vietnam). For 359 /1181 (30%) this was their first pregnancy (note half of the Romanian
90 mothers were experiencing their first pregnancy whilst Pakistan had the smallest proportions
91 of women experiencing their first pregnancy across sites). The sample was diverse in terms of
92 level of education: 4% none, 11% primary, 48% secondary, 16% vocational and 21%
93 university (lowest to highest level of maternal education, respectively: Pakistan, Ghana,
94 Jamaica, South Africa, Vietnam, Sri Lanka, Philippines and Romania).

95 Procedure

96 Information sheets, consent forms and questionnaires were translated (using
97 guidelines from the World Health Organisation;
98 http://www.who.int/substance_abuse/research_tools/translation/en/) into the most frequently
99 spoken languages by the participants, who provided either written or audio-recorded

100 informed consent. Expectant mothers in their third trimester of pregnancy ($M = 33.23$ weeks
101 gestation, $SD = 3.36$) completed the PAI and reported on demographic factors/ reproductive
102 history as part of a structured interview. The Ethics Boards of each university approved the
103 EBLs-FR protocol (Valdebenito et al, 2020).

104 **Measures**

105 **Maternal-fetal attachment.** Expectant mothers completed the 18-item PAI (Muller,
106 1993). Participants rated how often they engaged in specific thoughts or behaviours towards
107 the fetus (e.g., “I feel love for the baby” or “I stroke the baby through my tummy”) on a 4-
108 point scale: 1 = *almost never*, 2 = *sometimes*, 3 = *often*, 4 = *almost always*. A review of MFA
109 questionnaires concluded that the PAI is psychometrically sound (e.g., Cronbach’s alpha
110 ranges between .81 and .93) and, unlike other measures, includes behaviours *and* thoughts
111 and feelings towards the fetus (van den Bergh and Simons, 2009).

112 **Background measures.** Expectant mothers also reported on their age, socioeconomic
113 status, education and previous pregnancies/ births.

114 **Data Analysis**

115 We analysed the data using a latent variable framework in *Mplus* (Version 8.4;
116 Muthén, & Muthén, 2018) and used confirmatory factor analysis (CFA) to test measurement
117 models and compare mean levels of MFA. Data screening indicated that there was no
118 variability in responses to item 3 “I enjoy feeling the baby move” in the Philippines and so it
119 was removed from further analyses. Furthermore, the limited spread in the 4 response options
120 across sites for the remaining the items indicated scores should be collapsed into
121 dichotomous indicators (i.e., disagree/agree). This is in line with Rutkowski and colleagues’
122 (2019) recommended approach for dealing with floor/ceiling effects in response categories.
123 Analyses applied the weighted least squares mean and variance adjusted (WLSMV)
124 estimator. Following Mullers’ (1993) original contention that MFA is unidimensional, we

125 tested a 1-factor model alongside a 3-factor solution reflecting the dimensions of anticipation,
126 differentiation and interaction suggested by some previous studies (e.g., Pallant, Haines,
127 Hildingsson, Cross & Rubertsson, 2014). We evaluated model fit using three primary criteria:
128 Comparative Fit Index (CFI) > 0.90, Tucker Lewis Index (CFI) > 0.90, Root Mean Square
129 Error of Approximation (RMSEA) < 0.08 (Brown, 2015). To test measurement invariance
130 across site and parity we used multigroup CFA, which involves systematically adding
131 equality constraints to the model and testing the change in model fit of these nested models
132 (Byrne, 2012). Nested model comparisons were judged to be invariant if the CFI decreased
133 by ≤ 0.020 and RMSEA increased by $\leq .003$ (Svetina, Rutkowski, & Rutkowski, 2020). First,
134 we used a configural model to test for equivalence in the pattern of item loadings across site
135 and then parity groups (i.e., the organisation of the construct is similar). If this model showed
136 acceptable fit we then proceeded to test metric (weak factorial) invariance, specifying that
137 factor loadings were equal across sites (i.e., each item contributes in a similar way to the
138 construct). If metric invariance was not achieved, we sought to improve model fit by
139 inspecting modification indices to evaluate whether releasing item constraints would yield a
140 partially invariant model. Next, for items that showed metric invariance, we tested for scalar
141 (strong factorial) invariance, which involves equivalence of item thresholds (i.e., the cut-off
142 underlying the distribution of scores are consistent). Finally, if we established scalar
143 invariance we proceeded to test the mean differences in MFA by constraining the mean of the
144 reference group to zero and freely estimating the other group means (Byrne, 2012).

145 **Results**

146 **MFA Factor Structure**

147 Both the 1-factor and 3-factor solution showed an acceptable fit to the data for all
148 sites (Table 2). However, given the high overlap between the 3 factors ($r = > .8$) we
149 proceeded to test the across-site equivalence of the 1-factor solution.

150 Tests of Measurement Invariance Across Site

151 The configural model showed poor model fit, CFI = 0.627, TLI = 0.633, RMSEA =
152 0.11, SRMR = 0.061. Inspection of the modification indices suggested the removal of
153 Pakistan would improve the model fit. Indeed, the configural model for the 7 remaining sites
154 showed good model fit, CFI = 0.925, TLI = 0.912, RMSEA = 0.05, SRMR = 0.061. Adding
155 metric constraints did not significantly reduce model fit: CFI = 0.921, TLI = 0.914, RMSEA
156 = 0.05, SRMR = 0.075, but imposing constraints to examine scalar invariance did reduce
157 model fit. Inspection of modification indices led to releasing equality constraints of factor
158 intercepts for 15 items (items 10 “*I know when the baby is asleep*”, 12 “*I feel love for the*
159 *baby*” and 16 “*I stroke the baby through my tummy*” were invariant). Thus, a partially scalar
160 invariant model was considered to have an acceptable model fit, CFI = 0.901, TLI = 0.897,
161 RMSEA = 0.060.

162 Cross-cultural Differences in Prenatal Attachment

163 Using the partial scalar-invariant model, we tested for mean differences in the latent
164 factor across sites. We adopted a Bonferroni correction and adjusted the alpha level (i.e., $p <$
165 $.007$) to account for multiple comparisons. With Ghana as the reference site, we found mean
166 between-site differences in MFA, with lower levels in Vietnam, $b = -.50$ $z = -3.78$ $p < .001$,
167 and higher levels in Sri Lanka, $b = .73$, $z = 3.00$, $p < .001$, however no significant contrasts
168 with expectant mothers in Jamaica, Romania, Philippines and South Africa.

169 Parity and Prenatal Attachment

170 The model testing the equivalence of the configural model across parity showed
171 acceptable fit, CFI = 0.911, TLI = 0.894, RMSEA = 0.053, SRMR = 0.052. Adding metric
172 constraints led to a slight improvement in model fit, CFI = 0.912, TLI = 0.902, RMSEA =
173 0.051, SRMR = 0.06 and imposing constraints to examine scalar invariance did not
174 significantly reduce model fit, CFI = 0.903, TLI = 0.902, RMSEA = 0.052, SRMR = 0.066.

175 We subsequently compared the mean of the MFA latent factor across primiparous and
176 multiparous women, which demonstrated higher MFA in first-time mothers: $b = -.21$, $z = -$
177 2.19 , $p = .029$.

178 **Discussion**

179 Evidence for links between MFA and clinically relevant pre- and postnatal behaviours
180 (Rollè et al, 2020; Tichelman, 2019) has relied heavily on studies from a few HICs.

181 Addressing this gap, 1,181 expectant mothers completed the PAI to examine the conceptual
182 equivalence of MFA across eight LMICs: Ghana, Jamaica, Pakistan, Philippines, Romania,
183 South Africa, Sri Lanka, and Vietnam. The PAI showed conceptual and measurement
184 equivalence for pregnant women in seven of the eight sites, with mean levels of MFA being
185 lowest among expectant mothers in Vietnam and highest among expectant mothers in Sri
186 Lanka. While conceptually similar across levels of parity, MFA was greater in first-time
187 mothers.

188 **A Modified Measure of MFA shows Cross-Cultural Equivalence**

189 Consistent with findings from studies that have adapted the PAI for use in non-
190 English speaking HICs (e.g., Pavše, Tul & Velikonja, V., 2019), our analyses support a one-
191 factor MFA model. Similar to previous research with the PAI in India (Lamba et al, 2018),
192 the items contributing to MFA were dichotomised into agree/disagree options. The MFA
193 latent factor exhibited partial measurement invariance across seven out of the eight sites –
194 with some of item thresholds freely estimated at the scalar level of invariance. Taken
195 together, this suggests that a simplified two-option (agree / disagree) PAI is appropriate for
196 use across culturally diverse groups, which should increase confidence in the validity of
197 cross-cultural comparisons, as well as in the use of the PAI in efforts to improve the health
198 and wellbeing of women across the world (UN General Assembly, 2015).

199 That said, the PAI did not pass the first level of equivalence testing in Pakistan.
200 Closer inspection of item responses in Pakistan revealed a near-floor effect for seven items.
201 For example, few expectant Pakistani mothers endorsed items such as; *I stroke the baby*
202 *through my tummy* or *I imagine calling the baby by name*. This may reflect other contrasts
203 between Pakistan and the other sites, including elevated rates of infant mortality (i.e., < 5
204 years of age = 74 per 1000 live births), poverty (i.e., GDP pc = \$1550) and education (as
205 highlighted in Table 1: expectant mothers in Pakistan received significantly lower levels of
206 education than all sites aside from Ghana). The lack of item endorsement may reflect a
207 coping strategy for the mothers. For example, in seminal ethnographic research in the Alto do
208 Cruzeiro, a shantytown in northeast Brazil, Sheper-Hughes (1992) described how, in the
209 context of high infant mortality, impoverished mothers inhibited attachment towards their
210 infant after birth (e.g., not attributing human qualities towards their infants). Alternatively,
211 prevailing belief systems may render specific items or explicit endorsement of items
212 inappropriate. Ethnographic studies have emphasised expectant mothers in Pakistan are very
213 discreet about their pregnancies, with open conversations both within and outside of the
214 family seen as immodest (i.e., inferring disclosure of sexual activity) and inviting *nazar* (the
215 evil eye of jealousy), which may harm the unborn infant (Qureshi & Pacquiao, 2013; Qamar,
216 2016). Thus, women may internalise rather than externalise their developing bond.
217 Highlighting the importance of cultural appropriateness, Arafah et al. (2020) included four
218 new items in the PAI to capture the MFA amongst Arabic-speaking women in Qatar (e.g., ‘*I*
219 *am careful with my activities so nothing will hurt my baby*’). Future qualitative research
220 might therefore help highlight relevant questions for pregnant women in Pakistan or whether
221 the MFA construct lacks validity in this context.

222 **Site-Specific Differences In MFA**

223 While we often lack good cross-cultural research, establishing the conceptual and
224 measurement equivalence of measures across different cultures is a key pre-requisite for
225 drawing valid group comparisons (Boer, Hanke & He, 2018). Having established that the PAI
226 shows measurement invariance across seven sites, we found lower levels of MFA in Vietnam
227 and higher levels in Sri Lanka, than in the other five countries. One factor that might
228 contribute to these site contrasts is variation in antenatal care. For example, in Sri Lanka the
229 overwhelming majority of expectant mothers use the free, comprehensive maternal healthcare
230 package, which includes antenatal classes that encourage expectant mothers to promote
231 specific behaviours, seek partner support and to think about their developing infants as
232 individuals (Hemachandra, 2011). Future research is needed to unpack the, potentially
233 diverse, origins of differences in MFA, for example cultural norms, sampling and economic
234 factors. Our study reinforces the importance of testing the equivalence of measures in multi-
235 site studies in order to make meaningful comparisons.

236 **First-time pregnancy: a time to reflect?**

237 First-time mothers reported higher MFA than mothers in later pregnancies. While
238 similar results studies have been reported in high- e.g., (Tichleman et al, 2020) and upper-
239 middle income countries (e.g., Turkey; Özcan et al, 2018), the measurement invariance tests
240 employed in the current study increase the confidence that there is a true and meaningful
241 effect of parity. One simple explanation is that first-time mothers have greater psychological
242 space for thinking about their new infant than mothers who are already taking care of
243 younger infants. Our results suggest this parity effect is culturally universal – indeed, the
244 magnitude of this effect appears stronger in this study than in previous meta-analyses
245 (Yarcheski et al 2009; Tichleman et al, 2019).

246 **Strengths and Limitations**

247 The inclusion of data from eight LMICs is a key strength of the study. Notably,
248 similar studies of measurement equivalence have excluded data from LMICs due to a low
249 response rate (e.g., Zhang, 2020). That said, our samples were recruited using a non-
250 probabilistic sampling strategy, which potentially limits the generalisability of our results to
251 the wider population. Furthermore, although the average rate of recruitment was high (82%),
252 there was between-site variability (i.e., ranging from 50% in Sri Lanka to 98% in Pakistan)
253 which suggests further research is required to rule out the possibility that elevated rates of
254 MFA reported by expectant mothers in Sri Lanka are not the result of selection bias. In
255 addition, sample characteristics differed across sites, for example in terms of education (see
256 Table 1). However, having established the measurement properties of the PAI as an index of
257 MFA, future research can examine the cultural universality / specificity of these associations
258 as well explore the use of the PAI as a screener for maternal behaviours that may place
259 children at risk.

260 **Conclusions**

261 By adapting the PAI to yield a simple but valid tool that shows cross-cultural
262 equivalence in seven LMICs and across birth order, we hope to stimulate further work
263 examining prenatal psychological processes underpinning maternal and infant adjustment
264 across the first 1000 days.

265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288

References

- Arafah, D., Thomas, B., Fenton, T.R., Sabr, Y., & Metcalfe, A.(2020) Validity and reliability of the Arabic version of Muller’s prenatal attachment inventory. *Journal of Psychosomatic Obstetrics and Gynecology*. DOI: 10.1080/0167482X.2020.1713083
- Boer, D., Hanke, K., & He, J. (2018). On Detecting Systematic Measurement Error in Cross-Cultural Research: A Review and Critical Reflection on Equivalence and Invariance Tests. *Journal of Cross-Cultural Psychology*, 49(5), 713-734. DOI: 10.1177/0022022117749042
- Brandon, A. R., Pitts, S., Denton, W. H., Stringer, C. A., & Evans, H. M. (2009). A History of the Theory of Prenatal Attachment. *Journal of prenatal & perinatal psychology & health*, 23(4), 201–222.
- Brown, T. (2015). *Confirmatory Factor Analysis for Applied Research* (2nd ed.). London, UK: Guilford Press.
- Buffa, G., Dahan, S., Sinclair, I., St-Pierre, M., Roofigari, N., Mutran, D., Rondeau, J.-J., Dancause, K.N. (2018) Prenatal stress and child development: A scoping review of research in low- and middle-income countries. *PLoS ONE*, 13, art. no. e0207235, DOI: 10.1371/journal.pone.0207235
- Byrne, B. (2012) *Structural Equation Modeling with Mplus: Basic Concepts, Applications, and Programming* (Multivariate Applications Series). Routledge; New York.
- Cinar, N., Caka, S.Y., Topal, S., Yuvaci, H.U., Erkorkmaz, U. (2017) The relation of health-related practices of pregnant women, fatigue and prenatal attachment. *Journal of the College of Physicians and Surgeons Pakistan*, 27, 693-698.
- Commission on Health Research for Development (1990) *Health Research: Essential Link to Equity in Development*. Oxford University Press: New York.

- 289 Cranley, M. (1981). Development of a tool for the measurement of maternal attachment
290 during pregnancy. *MS Nursing Research*, 30, 281-284. doi:10.1097/00006199-
291 198109000-00008
- 292 Edhborg, M, Nasreen, H-E, Kabir, Z.N. (2011) Impact of postpartum depressive and anxiety
293 symptoms on mothers' emotional tie to their infants 2–3 months postpartum: a
294 population-based study from rural Bangladesh. *Archives of Womens Mental Health*.
295 14, 307-16. DOI: 10.1007/s00737-011-0221-7
- 296 Foley, S., & Hughes, C. (2018) Great expectations? Do mothers' and fathers' prenatal
297 thoughts and feelings about the infant predict parent-infant interaction quality? A meta-
298 analytic review. *Developmental Review*, 48, 40-54. DOI: 10.1016/j.dr.2018.03.007
- 299 Field, T. (2010). Postpartum depression effects on early interactions, parenting, and safety
300 practices: A review. *Infant Behavior And Development*, 33, 1-6.
301 doi:10.1016/j.infbeh.2009.10.005
- 302 Fisher, J., Mello, M. C. D., Patel, V., Rahman, A., Tran, T., Holton, S., & Holmes, W.
303 (2012). Prevalence and determinants of common perinatal mental disorders in women
304 in low-and lower-middle-income countries: a systematic review. *Bulletin of the World*
305 *Health Organization*, 90: 139-149. doi: 10.2471/BLT.11.091850
- 306 Henrich, J., Heine, S.J., & Norenzayen, A. (2010) The weirdest people in the world?
307 *Behavioral and Brain Sciences*, 33, 1 – 75. doi:10.1017/S0140525X0999152X
- 308 Hemachandra, N. (2011) *Maternal Care Package: A guide to field healthcare workers*.
309 Family Health Bureau, Ministry of Health. Sri Lanka.
- 310 Lamba, N., Jadva, V., Kadam, K., & Golombok, S. (2018) The psychological well-being and
311 prenatal bonding of gestational surrogates. *Human Reproduction*, 33, 646-653. DOI:
312 10.1093/humrep/dey048

- 313 Laxton-Kane, M., & Slade, P. (2002) The role of maternal prenatal attachment in a woman's
314 experience of pregnancy and implications for the process of care. *Journal of*
315 *Reproductive and Infant Psychology*, 20, 253-266. DOI:
316 10.1080/0264683021000033174
- 317 Mills-Koonce, W., Willoughby, M., Zvara, B., Barnett, M., Gustafsson, H., & Cox, M. J.
318 (2015). Mothers' and fathers' sensitivity and children's cognitive development in low-
319 income, rural families. *Journal of Applied Developmental Psychology*, 38, 1-10.
320 doi:10.1016/j.appdev.2015.01.001
- 321 Lindgren, K. (2001). Relationships among maternal-fetal attachment, prenatal depression,
322 and health practices in pregnancy. *Research in Nursing and Health*, 24, 203-217.
323 doi:10.1002/nur.1023
- 324 Lingeswaran A, Bindu H. (2012) Validation of Tamil Version of Cranley's 24-Item
325 Maternal-Fetal Attachment Scale in Indian Pregnant Women. *J Obstetrics and*
326 *Gynecology India*. 62, 630-34. DOI: 10.1007/s13224-012-0175-3
- 327 Muller, M. E. (1993). Development of the Prenatal Attachment Inventory. *Western Journal of*
328 *Nursing Research*, 15(2), 199-215. DOI: 10.1177/019394599301500205
- 329 Muthén, L. K., & Muthén, B. (2018). *Mplus. The comprehensive modelling program for*
330 *applied researchers: user's guide 5*. Los Angeles: Muthén, B & Muthén, LK.
- 331 Özcan, N.K., Boyacıoğlu, N.E., Dikeç, G. Dinç, H., Enginkaya, S. & Tomruk,
332 N (2018) Prenatal and Postnatal Attachment Among Turkish Mothers Diagnosed with a
333 Mental Health Disorder. *Issues in Mental Health Nursing*, 39, 795-801.
334 DOI: 10.1080/01612840.2018.1455773
- 335 Pallant, J.F., Haines, H.M., Hildingsson, I., Cross, M., & Rubertsson, C. (2014) Psychometric
336 evaluation and refinement of the Prenatal Attachment Inventory. *Journal of*

- 337 *Reproductive and Infant Psychology*, 32, 112-125. DOI:
338 10.1080/02646838.2013.871627
- 339 Parsons, C.E., Young, K.S., Rochat, T.J., Kringelbach, M.L., Stein, A. (2012) Postnatal
340 depression and its effects on child development: A review of evidence from low- and
341 middle-income countries. *British Medical Bulletin*, 101, 57-79. DOI:
342 10.1093/bmb/ldr047
- 343 Pavše, L., Tul, N., & Velikonja, V. (2019) Analysis of the internal structure of the Slovenian
344 version of the Prenatal Attachment Inventory (PAI) [Analiza notranje strukture
345 slovenskega prevoda Lestvice vezi med nosečnico in plodom (PAI)]. *Psiholoska*
346 *Obzorja*, 28, 11-18. DOI: 10.20419/2019.28.496
- 347 Punamäki, R.L., Isosävi, S., Qouta, S.R., Kuittinen, S., Diab, S.Y.(2017) War trauma and
348 maternal–fetal attachment predicting maternal mental health, infant development, and
349 dyadic interaction in Palestinian families. *Attachment and Human Development*, 19,
350 463-486. DOI: 10.1080/14616734.2017.1330833
- 351 Qureshi, R. & Pacquiao, D. (2013) Ethnographic study of experiences of Pakistani women
352 immigrants with pregnancy, birthing, and postpartum Care in the United States and
353 Pakistan. *Journal of Transcultural Nursing*. 24, 355–62. doi: 10.1177/
354 1043659613493438.
- 355 Rollè, L., Giordano, M., Santoniccolo, F., Trombetta, T. (2020) Prenatal attachment and
356 perinatal depression: A systematic review. *International Journal of Environmental*
357 *Research and Public Health*, 17, art. no. 2644. DOI: 10.3390/ijerph17082644
- 358 Rutkowski, L., Svetina, D. & Liaw, Y-L. (2019): Collapsing Categorical Variables and
359 Measurement Invariance. 0, 1 – 13. *Structural Equation Modeling: A Multidisciplinary*
360 *Journal*. doi.org/10.1080/10705511.2018.1547640

- 361 Sheper-Hughes, N. (1992) *Death without Weeping: The Violence of Everyday Life in Brazil*.
362 Berkeley, Los Angeles, Oxford: University of California Press.
- 363 Svetina, D., Rutkowski, L. & Rutkowski, D. (2020) Multiple-Group Invariance with
364 Categorical Outcomes Using Updated Guidelines: An Illustration Using Mplus and the
365 lavaan/semTools Packages. *Structural Equation Modeling: A Multidisciplinary*
366 *Journal*, 27, 111-130. DOI: 10.1080/10705511.2019.1602776
- 367 Tichelman, E., Westerneng, M., Witteveen, A.B., Van Baar, A.L., Van Der Horst, H.E., De
368 Jonge, A., Berger, M.Y., Schellevis, F.G., Burger, H., Peters, L.L. (2019) Correlates of
369 prenatal and postnatal mother to-infant bonding quality: A systematic review. *PLoS*
370 *ONE*, 14, art. no. e0222998, DOI: 10.1371/journal.pone.0222998
- 371 UN General Assembly, *Transforming our world : the 2030 Agenda for Sustainable*
372 *Development*, 21 October 2015, A/RES/70/1, available at:
373 <https://www.refworld.org/docid/57b6e3e44.html> [accessed 24 September 2020]
- 374 Valdebenito, S., Murray, A.L., Hughes, C., Baban, A., Asvini, D. ... Eisner, M. (2020)
375 Evidence for Better Lives Study: A comparative birth-cohort study on child exposure to
376 violence and other adversities in eight low- and middle-income countries –
377 Foundational Research. *BMJ Open*, 10, e034986.
- 378 van den Bergh, B., & Simons, A. (2009). A review of scales to measure the mother-foetus
379 relationship. *Journal of Reproductive and Infant Psychology*, 27, 114-126.
380 doi:10.1080/02646830802007480
- 381 Vidyasagar, D. (2006) Global notes: the 10/90 gap disparities in global health
382 research. *Journal of Perinatology*, 26, 55–56 DOI: 10.1038/sj.jp.7211402
- 383 Walsh, J. (2010). Definitions matter: If maternal-fetal relationships are not attachment, what
384 are they? *Archives of women's mental health*, 13, 449-451. doi:10.1007/s00737-010-
385 0152-8

- 386 Woody, C.A. Ferrari, A.J., Siskind, D.J., Whiteford, H.A. & Harris, M.G. (2017) A
387 systematic review and meta-regression of the prevalence and incidence of perinatal
388 depression. *Journal of Affective Disorders*, 219, 86-92. 10.1016/j.jad.2017.05.003.
- 389 Yarcheski, A., Mahon, N., Yarcheski, T., Hanks, M., & Cannella, B. (2009). A meta-analytic
390 study of predictors of maternal-fetal attachment. *International Journal of Nursing*
391 *Studies*, 46, 708-715. doi:10.1016/j.ijnurstu.2008.10.013
- 392 Zhang, R.J. (2020) Social trust and satisfaction with life: A cross-lagged panel analysis based
393 on representative samples from 18 societies. *Social Science & Medicine*, 251, 112901.
394 DOI: 10.1016/j.socscimed.2020.112901.

395 Funding

396 The work of the Evidence for Better Lives Study was supported by the Jacobs Foundation,
397 UBS Optimus Foundation, Fondation Botnar, the Consuelo Zobel Alger Foundation, the
398 British Academy, the Cambridge Humanities Research Grants Scheme, the ESRC Impact
399 Acceleration Account Programme, a Queensland University of Technology Postgraduate
400 Research Award, Higher Degree Research Student Supplementary Research Funding from
401 Queensland University of Technology, the University of Edinburgh College Office for the
402 College of Arts, the Humanities and Social Sciences SFC ODA Global Challenges Internal
403 Fund, the University of Cambridge GCRF Quality Research Fund and the Wolfson Professor
404 of Criminology Discretionary Fund. The views expressed are those of the authors and not
405 necessarily those of the funding bodies. The first author was funded by an Economic and
406 Social Research Council Post-Doctoral Fellowship. The content of this paper is the
407 responsibility of the authors and does not reflect official views of these funding bodies.

408 Conflicts of interest/Competing interests

409 The authors declare that the research was conducted in the absence of any commercial or
410 financial relationships that could be construed as a potential conflict of interest.

Table 1. *Site Specific Sample Demographics.*

	Ghana <i>n</i> = 146	Jamaica <i>n</i> = 151	Pakistan <i>n</i> = 143	Philippines <i>n</i> = 152	Romania <i>n</i> = 148	South Africa <i>n</i> = 143	Sri Lanka <i>n</i> = 149	Vietnam <i>n</i> = 149	Between-Site Differences	
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>F</i>	η^2
Age of mother (years)	29.05 (6.38)	25.57 (5.69)	27.28 (5.24)	27.63 (6.05)	30.07 (4.62)	26.89 (5.99)	29.75 (5.56)	29.93 (5.16)	13.07***	.07
Gestation (weeks)	34.35 (3.78)	33.93 (3.06)	31.82 (3.72)	32.75 (2.98)	33.16 (3.12)	34.25 (3.31)	32.38 (2.86)	33.21 (3.00)	11.18	.06
Grades passed in education system	8.33 (4.44)	10.46 (1.06)	7.80 (4.79)	11.44 (2.66)	12.80 (1.93)	10.51 (1.88)	11.83 (1.47)	10.53 (2.48)	49.67	.24
	%	%	%	%	%	%	%	%	χ^2	<i>Cramer's V</i>
First pregnancy	19.9	26.5	12.6	25	50	36.4	43	29.5	71.93	.25

Note. *** $p < .001$

Table 2. *Model Fit Indices for a 1-factor and 3-factor model of the Prenatal Attachment Inventory By Site*

Site	<u>1-factor Model Fit</u>			<u>3-factor Model Fit</u>		
	RMSEA	CFI	TLI	RMSEA	CFI	TLI
Ghana	0.07	0.939	0.93	.066	.948	.939
Jamaica	0.044	0.935	0.926	.036	.957	.949
Pakistan	0.038	0.962	0.957	.036	.967	.962
Philippines	0.037	0.954	0.947	.036	.959	.952
Romania	0.086	0.829	0.804	.086	.827	.798
South Africa	0.028	0.973	0.969	.015	.992	.991
Sri Lanka	0.047	0.928	0.917	.047	.929	.917
Vietnam	0.065	0.892	0.876	.067	.888	.869