RESEARCH PAPER

Psychometric Validation of a Four-Factor Children's Mental Health Model During COVID-19 in Kerala: A CFA Approach

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Abstract
Reliable and valid measuring instruments are crucial to assessing mental well-being among children during public health emergencies. Using cross-sectional data from 383 caregivers of children aged 5 to 15 years in Kerala, India, during the second wave of COVID-19, this study formally evaluates the psychometric properties of a four-factor CB-SEM instrument capturing parental psychological context, family structure, parenting behaviour, and child symptom profiles corresponding to Parental Mental Health, Child Information, Parents' Attitude Toward Child, and Child Mental Health respectively. The dataset comprised 12 ordinal-scale indicators and 3 continuous composite scores. CB-SEM was implemented in SmartPLS. Global fit was mixed: incremental indices were acceptable (CFI = 0.949, TLI = 0.937, GFI = 0.924, SRMR = 0.055), while absolute indices were borderline to mediocre (χ^2/df = 4.287, RMSEA = 0.093), partly due to maximum likelihood estimation with predominantly ordinal indicators. Child Mental Health (AVE = 0.974), Child Information (AVE = 0.955), and Parents' Attitude Toward Child (AVE = 0.689) demonstrated strong psychometric characteristics. Parental Mental Health showed poor convergent validity (AVE = 0.302), marginal composite reliability (0.671), and a negative outer loading for the COVID-19 exposure indicator (−0.133). Discriminant validity was not supported between Parental Mental Health and Child Mental Health. The findings indicate that three of the four constructs are suitable for research and screening use in Kerala, while the Parental Mental Health domain requires refinement before further application.

Keywords: COVID-19; confirmatory factor analysis; CB-SEM; SmartPLS; measurement validation; parental mental health; AVE; discriminant validity; Kerala; India
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1. Introduction

Psychometric validation is essential to ensure that research conducted using questionnaires is an accurate representation of the underlying constructs (Hair et al., 2010; Kline, 2016). The lack of validation might lead to conclusions regarding risk factors, prevalence, or target interventions being based on measurement tools that inadequately measure the desired constructs. This becomes a particular issue during pandemics, whereby data collection is fast-tracked, sample populations are based on convenience, and measures used have been adjusted from elsewhere.

A four-factor measurement model comprising Parental Mental Health, Child Information, Parents' Attitude Toward Child, and Child Mental Health was originally proposed and validated in Bangladesh (Yeasmin et al., 2020) and subsequently applied in the Kerala, India context (Ramachandran et al., 2026). The latent covariance estimates and structural pathways derived from this dataset are presented in a companion article (Divya et al., 2026), which addresses the substantive question of how parental distress, parenting behaviour, and family composition relate to child psychological difficulties. The present paper addresses a distinct methodological question — specifically, whether these four constructs, as operationalised in the Kerala dataset, meet accepted psychometric standards. Following the two-step approach to SEM (Anderson & Gerbing, 1988), measurement model validation should be established and reported separately from structural inference. The primary objectives are: (i) to assess the global fit of the four-factor CB-SEM model; (ii) to examine outer loadings of all 15 indicators; (iii) to evaluate construct reliability and convergent validity; and (iv) to test discriminant validity using the Fornell–Larcker criterion (Fornell & Larcker, 1981).

2. Methods

2.1 Sample and Data Collection

Full details of the study design, setting, sampling, data collection procedure, and construct operationalisation are reported in the companion structural pathways paper (Divya et al., 2026). Briefly, 383 parents of children aged 5–15 years residing in Kerala completed a structured self-administered online Google Forms

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questionnaire during the second wave of COVID-19, following voluntary electronic informed consent.

2.2 Statistical Analysis

Confirmatory factor analysis was conducted using CB-SEM in SmartPLS, following the two-step approach of Anderson and Gerbing (1988). All four constructs were specified as reflective measurement models. Model fit was evaluated using χ^2/df (≤ 5.0), RMSEA (< .080), CFI, TLI, GFI (> .90), and SRMR (< .080). Convergent validity was assessed using AVE (target ≥ 0.50) and composite reliability (target ≥ 0.70; Fornell & Larcker, 1981). Discriminant validity was evaluated using the Fornell–Larcker criterion. Because 12 of 15 indicators are ordinal, maximum likelihood (ML) estimation which assumes continuous, normally distributed data, is known to inflate chi-square and RMSEA (Kline, 2016; MacCallum et al., 1996); this is treated as a methodological limitation throughout.

3. Results

3.1 Global Model Fit

Table 1 presents the model fit indices. Incremental indices - CFI (0.949), TLI (0.937), GFI (0.924), NFI (0.935) were higher than 0.90, and SRMR (0.055) was below 0.080, indicating acceptable fit. However, $\chi^2(84) = 360.100$, $\chi^2/df = 4.287$, and RMSEA = 0.093 [90% CI: 0.083, 0.103] were elevated a pattern consistent with the known inflation of ML-based fit statistics when indicators are predominantly ordinal (Kline, 2016; MacCallum et al., 1996). Figure 1 presents the CB-SEM path diagram for the four-factor model.

Table 1: *Global Model Fit Indices - CB-SEM Four-Factor Model (N = 383)*

Fit Index	Value	Recommended Threshold	Verdict
$\chi^2(84)$	360.100	-	-
χ^2/df	4.287	≤ 3.0 (ideal); ≤ 5.0 (acceptable)	Borderline
RMSEA [90% CI]	0.093 [0.083, 0.103]	< .060 (good); < .080 (acceptable)	Mediocre
CFI	0.949	> .90	Acceptable
TLI	0.937	> .90	Acceptable
GFI	0.924	> .90	Acceptable
NFI	0.935	> .90	Acceptable
SRMR	0.055	< .080	Good

Note. RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; TLI = Tucker–Lewis Index; GFI = Goodness-of-Fit Index; NFI = Normed Fit Index; SRMR = Standardised Root Mean Square Residual. Elevated χ^2/df and RMSEA are partly attributable to ML estimation with predominantly ordinal indicators.

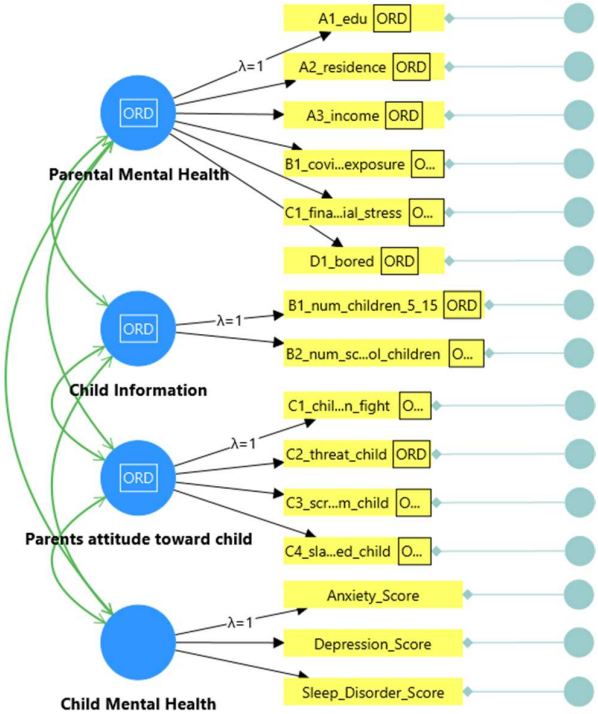

Figure 1. *Path Diagram of the Four-Factor CB-SEM Measurement Model (SmartPLS Output)*

3.2 Outer Loadings

Table 2 illustrates the standardised outer loadings for all the 15 indicators. Child Mental Health had very high loadings on all three continuous composite measures (0.987 each). The loading of Parents' Attitude Toward Child on its four ordinal indicators was consistently strong (0.812-0.864). The Child Information measure had very high loadings on both its ordinal count indicators (0.840 and 1.097). Parental Mental Health showed a heterogeneous pattern: boredom loaded highest (0.990), financial stress moderately (0.509), socioeconomic indicators moderately (0.305–0.496), and critically COVID-19 exposure displayed a negative loading (−0.133, p = .018), indicating that this indicator is directionally misaligned with the other five Parental Mental Health indicators.

Table 2: *Standardised Outer Loadings and Parameter Estimates - CB-SEM (SmartPLS)*

Indicator	Construct	Loading	Estimate	SE	p
A1_edu (ordinal)	Parental Mental Health	0.305	1.000	n/a	n/a
A2_residence (ordinal)	Parental Mental Health	0.496	1.261	0.237	< .001
A3_income (ordinal)	Parental Mental Health	0.464	1.775	0.342	< .001
B1_covid_exposure (ordinal)	Parental Mental Health	−0.133	−0.176	0.074	.018
C1_financial_stress (ordinal)	Parental Mental Health	0.509	1.447	0.277	< .001
D1_bored (ordinal)	Parental Mental Health	0.990	3.021	0.487	< .001
B1_num_children_5_15 (ordinal)	Child Information	1.097	1.000	n/a	n/a
B2_num_school_children (ordinal)	Child Information	0.840	0.852	0.207	< .001
C1_children_fight (ordinal)	Parents' Attitude Toward Child	0.822	1.000	n/a	n/a
C2_threat_child (ordinal)	Parents' Attitude Toward Child	0.812	0.988	0.054	< .001
C3_scream_child (ordinal)	Parents' Attitude Toward Child	0.864	1.051	0.052	< .001
C4_slapped_child (ordinal)	Parents' Attitude Toward Child	0.822	1.000	0.054	< .001
Depression_Score (continuous)	Child Mental Health	0.987	0.996	0.012	< .001
Anxiety_Score (continuous)	Child Mental Health	0.987	1.000	n/a	n/a
Sleep_Disorder_Score (continuous)	Child Mental Health	0.987	0.996	0.012	< .001

Note. Indicators labelled (ordinal) use ordered categorical or Likert-type response formats. Indicators labelled (continuous) are composite scores (range 4–16). A1_edu was the reference indicator for Parental Mental Health (estimate fixed to 1.000). n/a = not applicable (reference indicator). SE = standard error.

3.3 Reliability and Convergent Validity

Table 3 presents reliability and convergent validity indices. Child Mental Health (AVE = 0.974, CR = 0.991, α = 0.991) and Child Information (AVE = 0.955, CR = 0.963, α = 0.959) achieved outstanding performance, well above all recommended thresholds. Parents' Attitude Toward Child met all conventional thresholds (AVE = 0.689, CR = 0.899, α = 0.898). Parental Mental Health showed substantially weaker psychometric properties: Cronbach's alpha (0.398) and composite reliability (0.671) both fell below the 0.70 minimum, and AVE (0.302) fell well below the 0.50 threshold required for adequate convergent validity (Fornell & Larcker, 1981), indicating that the six ordinal indicators collectively explain less than one-third of construct variance.

Table 3: *Construct Reliability and Convergent Validity*

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Construct	Cronbach's α (Std.)	Cronbach's α (Unstd.)	CR (ρc)	AVE
Child Information	0.959	0.957	0.963	0.955
Child Mental Health	0.991	0.991	0.991	0.974
Parental Mental Health	0.398	0.464	0.671	0.302
Parents' Attitude Toward Child	0.898	0.898	0.899	0.689

Note. CR = composite reliability (ρc); AVE = average variance extracted. Recommended thresholds: Cronbach's α ≥ 0.70; CR ≥ 0.70; AVE ≥ 0.50 (Fornell & Larcker, 1981; Hair et al., 2010).

3.4 Discriminant Validity

The Fornell-Larcker criterion matrix is shown in Table 4. The Child Information (√AVE = 0.977) and Child Mental Health (√AVE = 0.987) clearly exhibited discriminant validity. The Parents' Attitude toward Child (√AVE = 0.830) almost satisfied the requirement of discriminant validity except for the fact that its highest correlations (0.802 with Child Mental Health and 0.715 with Parental Mental Health) were slightly below the diagonal. Parental Mental Health showed a clear violation: its correlation with Child Mental Health (0.863) exceeded its own √AVE (0.549), indicating that these two constructs share more variance with each other than each uniquely explains among its own indicators.

Table 4: *Discriminant Validity - Fornell–Larcker Criterion*

Construct	CI	CMH	PMH	PAC
Child Information (CI)	**0.977**			
Child Mental Health (CMH)	−0.093	**0.987**		
Parental Mental Health (PMH)	−0.065	0.863	**0.549**	
Parents' Attitude Toward Child (PAC)	−0.106	0.802	0.715	**0.830**

Note. CI = Child Information; CMH = Child Mental Health; PMH = Parental Mental Health; PAC = Parents' Attitude Toward Child. Bold diagonal values = square root of AVE; off-diagonal = inter-construct correlations. Discriminant validity is supported when each diagonal value exceeds all off-diagonal values in its row and column.

4. Discussion

A rigorous assessment of the psychometric properties of the four-factor CB-SEM measurement model was conducted on the Kerala COVID-19 data set. The pattern of mixed fit, acceptable incremental fit indices (CFI = 0.949, SRMR = 0.055) coupled with elevated absolute indices (RMSEA = 0.093), is an expected outcome of employing the ML estimator with the majority of the items being ordinal in nature (Kline, 2016; MacCallum et al., 1996). While incremental indices are less sensitive to this distortion, they provide consistent evidence of model validity. Future research must rely on estimators such as WLSMV.

Three out of the four latent variables exhibited good psychometric properties. Convergent validity was extremely high for Child Mental Health (AVE = 0.974, CR = 0.991), confirming that depression, anxiety, and sleep disorder cohere into a single underlying latent dimension. Parents' Attitude Toward Child and Child Information both satisfied all conventional reliability and AVE thresholds. Parental Mental Health, however, is the weakest link in the model. Its AVE (0.302) fails the 0.50 minimum (Fornell & Larcker, 1981), and its Cronbach's alpha (0.398) falls far below 0.70, primarily driven by the negative-loading COVID-19 exposure item (−0.133). This negative loading clearly indicates that the infection proximity variable is psychologically distinct from the financial stress and boredom captured by the other five indicators. Moreover, the inclusion of both socioeconomic and psychological variables within one construct introduces internal diversity, reducing reliability and AVE of this construct. The resulting discriminant validity violation with Child Mental Health (r = 0.863 > √AVE = 0.549) is a direct consequence of this weak construct specification, compounded by shared method variance from single-informant, single-timepoint reporting. Future models should separate socioeconomic background from psychological state indicators, remove the COVID-19 exposure item, and consider a validated parental distress scale. All substantive relationships between the four constructs, including the association between parental distress and children's wellbeing, are presented in the structural pathways paper (Divya et al., 2026).

5. Conclusion

In this study, four factors were identified in a CB-SEM measurement model namely, Parental Mental Health, Child Information, Parents' Attitude Toward Child, and Child Mental Health in 383 households in Kerala, India, during the pandemic of COVID-19 according to the two-stage method proposed by Anderson and Gerbing (1988). Incremental goodness of fit was successfully obtained, with CFI = 0.949, TLI = 0.937, GFI = 0.924, and SRMR = 0.055. Absolute fit indices were elevated (RMSEA = 0.093), attributable to the use of ML

estimation with predominantly ordinal data. Child Mental Health, Child Information, and Parents' Attitude Toward Child all had good psychometric qualities and were appropriate tools for conducting measurement research and screening in Kerala. Parental Mental Health requires further improvement, particularly the exclusion of the COVID-19 variable, separation between socio-economic status and psychological well-being items, and proper estimation procedure.

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