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Structural Validity and Internal Consistency of the Brazilian Portuguese Diabetes Eating Problem Survey–revised in Adolescents With Type 1 Diabetes

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Abstract

Introduction:

The Diabetes Eating Problem Survey–Revised (DEPS-R) is a diabetes-specific screening measure for disordered eating. A Brazilian Portuguese version was culturally adapted, but its internal structure had not been independently evaluated from item-level data.

Methods

The 16-item DEPS-R was completed by 175 adolescents with type 1 diabetes. Item distributions, corrected item–total correlations, Cronbach's alpha, ordinal alpha, and McDonald's omega were examined. Polychoric correlations informed tests of previously proposed one- and three-factor models, parallel analysis, Velicer's minimum average partial test, and exploratory factor analysis. Associations with glycated hemoglobin and body mass index-for-age were prespecified.

Results

Internal consistency was good (alpha = .835; ordinal alpha = .892; omega = .893). The one-factor model showed inadequate fit (CFI = .941, TLI = .932, RMSEA = .093, SRMR = .112). A published three-factor model fit better, but two factors correlated .914 and SRMR remained .090. Parallel analysis and the minimum average partial test supported two correlated factors; several items cross-loaded. Scores correlated with glycated hemoglobin (rho = .379) and body mass index-for-age (rho = .265).

Discussion

The total score has adequate internal consistency and clinically coherent external associations, but dimensionality was not unequivocal. The total score may support screening, whereas Brazilian subscales should not be recommended before independent replication.

Introduction

Type 1 diabetes requires repeated attention to food intake, insulin dosing, glucose monitoring, physical activity, and body weight. During adolescence, these treatment demands may interact with body-image concerns, dietary restraint, binge eating, and diabetes-specific compensatory behaviors such as intentional insulin restriction or omission. Disordered eating in type 1 diabetes is clinically important because it can coexist with psychological distress, hyperglycemia, acute metabolic complications, and increased long-term morbidity (De Paoli & Rogers, 2018; Pursey et al., 2020). Brief, condition-specific assessment is therefore relevant to clinical psychologists and other behavioral health professionals embedded in pediatric diabetes care.

The Diabetes Eating Problem Survey–Revised (DEPS-R) is a 16-item self-report screening measure developed for youth with type 1 diabetes (Markowitz et al., 2010). Its six-category response scale captures eating concerns and behaviors that generic eating-disorder measures may overlook, including insulin-related behaviors. The DEPS-R is a screening instrument rather than a diagnostic interview; elevated scores indicate a need for further assessment. The measure has been translated and examined in several languages and age groups, generally showing acceptable internal consistency (Altınok et al., 2017; Lv et al., 2021; Pinna et al., 2017; Saßmann et al., 2015; Wisting et al., 2013).

Evidence about the DEPS-R factor structure is less consistent. The original study supported use of a total score, whereas later studies described three or more components that differed across samples and languages (Pinna et al., 2017; Wisting et al., 2013, 2019). Recent Danish studies also identified item-level limitations and cautioned that previously proposed structures may not reproduce uniformly (Abild et al., 2025, 2026). Such instability matters clinically: reliability of a total score does not by itself establish that proposed subscales represent distinct psychological dimensions.

A Brazilian Portuguese version underwent translation, expert review, cultural adaptation, and pretesting before the present clinical study (Gonçalves et al., 2022). The measure has subsequently been used in a Brazilian clinical sample, but comprehensive structural evidence based on the original item-level responses has not been published (Cezar et al., 2022). The present study followed contemporary measurement-reporting recommendations (Gagnier et al., 2025) and aimed to evaluate item-level performance, structural validity, internal consistency, and hypothesis-based construct validity of the Brazilian Portuguese DEPS-R among adolescents with type 1 diabetes. We expected the total score to show adequate internal consistency and positive associations with glycated hemoglobin (HbA1c) and age- and sex-standardized body mass index (BMI-for-age). Because prior dimensional solutions have varied, competing structures were evaluated without assuming that a Brazilian subscale solution would necessarily replicate one previously reported elsewhere.

Method

Design and Setting

This cross-sectional psychometric study used data collected during the clinical measurement phase of a doctoral research project. Data were collected from August 2023, through April 2024, in a specialized public referral service for children and adolescents with diabetes in northeastern Brazil. Reporting was guided by the COSMIN reporting guideline for studies of measurement properties of patient-reported outcome measures (Gagnier et al., 2025).

Participants and Procedures

Eligible participants were 10–19 years old, had a clinical diagnosis of type 1 diabetes for at least 6 months, could read and write in Brazilian Portuguese, and used either continuous subcutaneous insulin

infusion or multiple daily insulin administration. Adolescents were not enrolled when communication, cognitive, hearing, or visual limitations prevented questionnaire completion or when acute clinical instability compromised participation. Recruitment occurred during scheduled outpatient visits. The parent study estimated a target of 172 participants and enrolled 175; all records with item-level DEPS-R data were included in the present analysis.

Participants completed the questionnaire in a private area of the service. For minors, written parental or legal-guardian consent and adolescent assent were obtained; participants aged 18 years or older provided written consent. The archived item-level file contained no missing DEPS-R responses and no values outside the permitted range.

Measure

The DEPS-R contains 16 items rated from 0 (never) to 5 (always), referring to the previous month. Item scores are summed to obtain a conventional total ranging from 0 to 80, with higher scores reflecting more frequent disordered eating behaviors (Markowitz et al., 2010). The Brazilian Portuguese version used here was produced through forward translation, synthesis, back-translation, expert review, pretesting, and review by an original instrument author (Gonçalves et al., 2022). Clinical variables used for hypothesis-based validity analyses were the most recent HbA1c value documented in the medical record and BMI-for-age z scores calculated from exact age, sex, height, and weight using the World Health Organization 2007 reference.

Statistical Analysis

Item means, standard deviations, response frequencies, corrected item–total correlations, floor and ceiling percentages, and alpha-if-item-deleted values were calculated. A floor or ceiling concentration was described when at least 15% of responses occurred in the lowest or highest category. Conventional Cronbach's alpha was calculated from the raw item covariance matrix, and a 95% percentile bootstrap interval was based on 5,000 resamples. Because the items are ordinal, standardized alpha from Pearson correlations, ordinal alpha from the polychoric matrix, and McDonald's omega total from a one-factor polychoric solution were also reported (Dunn et al., 2014).

Pairwise polychoric correlations were estimated by maximum likelihood from empirical response thresholds. Factorability was evaluated with the Kaiser–Meyer–Olkin statistic and Bartlett's test of sphericity. Dimensionality was assessed using Horn's parallel analysis with 5,000 random data sets and the 95th percentile criterion (Horn, 1965), together with Velicer's minimum average partial test (Velicer, 1976).

Two previously published structures were evaluated as confirmatory comparisons: a one-factor model containing all 16 items and a three-factor model composed of maladaptive eating habits (items 2, 3, 4, 5, 7, 12, 13, 14, and 15), preoccupation with thinness or weight (items 1, 6, 11, and 16), and maintaining

high glucose for weight control (items 8, 9, and 10) (Pinna et al., 2017; Wisting et al., 2013). Models were estimated from the polychoric matrix by unweighted least squares. Because the statistic was not mean-variance adjusted, chi-square, comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR) were treated as descriptive model-comparison indices rather than exact inferential tests. Approximate adequacy was judged by CFI/TLI values near or above .95, RMSEA near or below .06–.08, and SRMR near or below .08 (Flora & Curran, 2004).

When the prespecified structures were not unequivocally supported, principal-axis exploratory factor analysis with oblimin rotation was used to characterize the solution indicated by parallel analysis and the minimum average partial test. Pattern coefficients of at least .30 were interpreted, and cross-loadings were examined rather than removed solely to improve fit. Spearman correlations tested the prespecified associations of the total score with HbA1c and BMI-for-age. Correlations with age and diabetes duration and a sex comparison were examined as secondary analyses. All tests were two-sided. Analyses were conducted in Python 3.13.5 using NumPy 2.3.5, SciPy 1.17.0, and statsmodels 0.14.6.

Ethical Considerations

The protocol was approved by the Research Ethics Committee of the Federal Institute of Education, Science and Technology of Ceará (approval no. 4,130,397). The study was conducted in accordance with Brazilian research regulations and the principles of the Declaration of Helsinki.

Results

Participant and Score Characteristics

The sample included 175 adolescents (52.6% female). Mean age was 14.72 years (SD = 2.32), and median diabetes duration was 4.0 years (interquartile range = 2.0–8.0). Mean HbA1c was 8.93% (SD = 2.07), and mean BMI-for-age z score was 0.29 (SD = 1.12). The DEPS-R total ranged from 2 to 62 (M = 24.70, SD = 12.40; median = 23, interquartile range = 16.0–33.5). Participant characteristics are summarized in Table 1.

Table 1
Participant and DEPS-R Score Characteristics

Characteristic	Value
Age, years	14.72 (2.32)
Female sex	92 (52.6%)
Diabetes duration, years	4.0 [2.0–8.0]
HbA1c, %	8.93 (2.07)
BMI-for-age z score	0.29 (1.12)
DEPS-R total score	24.70 (12.40)
DEPS-R median [IQR]	23 [16.0–33.5]
DEPS-R observed range	2–62

Note. N = 175. Values are mean (standard deviation), n (%), or median [interquartile range]. BMI = body mass index; DEPS-R = Diabetes Eating Problem Survey–Revised; HbA1c = glycated hemoglobin.

Item means ranged from 0.28 to 3.28 (Table 2). Marked floor concentrations were present for clinically severe or diabetes-specific behaviors: 79.4% responded never to self-induced vomiting (item 8) and deliberately maintaining high glucose to lose weight (item 9), 71.4% to eating until urinary ketones cleared (item 10), 68.0% to feeling fat when taking all insulin (item 11), 64.6% to preferring thinness over good diabetes control (item 16), and 59.4% to skipping the next insulin dose after overeating (item 13). Ceiling concentrations occurred for items 1, 3, and 12. Corrected item–total correlations ranged from .315 to .543.

Table 2
Item-Level Descriptive Statistics, Reliability, and One-Factor Results

Item	Abbreviated content	M	SD	Floor %	Ceiling %	Corrected r_it	α if deleted	Loading / h^2
1	Weight loss is an important goal	2.15	1.84	25.7	19.4	0.441	0.828	0.523 / 0.273
2	Skip meals/snacks	1.78	1.43	23.4	5.7	0.543	0.821	0.617 / 0.381
3	Others say eating is out of control	2.67	1.66	13.1	21.1	0.527	0.821	0.543 / 0.295
4	Insufficient insulin after overeating	1.29	1.37	36.0	5.7	0.446	0.826	0.526 / 0.277
5	Eat more when alone	2.31	1.76	21.7	14.9	0.516	0.822	0.597 / 0.356
6	Difficulty losing weight and controlling diabetes	1.94	1.65	28.0	10.9	0.478	0.821	0.550 / 0.302
7	Avoid glucose checks when out of range	1.43	1.51	38.3	6.9	0.351	0.833	0.386 / 0.149
8	Self-induced vomiting	0.36	0.90	79.4	1.7	0.360	0.831	0.700 / 0.490
9	Keep glucose high to lose weight	0.28	0.67	79.4	0.6	0.435	0.831	0.753 / 0.568
10	Eat until urinary ketones clear	0.45	0.86	71.4	0.6	0.315	0.833	0.572 / 0.327
11	Feel fat when taking all insulin	0.66	1.13	68.0	1.7	0.471	0.826	0.703 / 0.494
12	Others say to care for diabetes better	3.28	1.65	6.9	36.0	0.478	0.825	0.538 / 0.290
13	Skip next insulin dose after overeating	0.76	1.19	59.4	2.9	0.326	0.833	0.505 / 0.255
14	Feel eating is out of control	2.23	1.57	16.6	12.6	0.524	0.822	0.537 / 0.288

Note. Floor and ceiling percentages are the proportions selecting 0 (never) and 5 (always). Corrected r_it = correlation between the item and the total of the remaining items. α if deleted is conventional Cronbach's alpha after deleting the item. Loading and h^2 are from the one-factor principal-axis solution based on the polychoric correlation matrix.

Item	Abbreviated content	M	SD	Floor %	Ceiling %	Corrected r_it	α if deleted	Loading / h²
15	Alternate very little and very large amounts	2.07	1.54	15.4	11.4	0.494	0.823	0.562 / 0.316
16	Prefer thinness to good diabetes control	1.03	1.71	64.6	11.4	0.527	0.821	0.707 / 0.500

Note. Floor and ceiling percentages are the proportions selecting 0 (never) and 5 (always). Corrected r_it = correlation between the item and the total of the remaining items. α if deleted is conventional Cronbach's alpha after deleting the item. Loading and h² are from the one-factor principal-axis solution based on the polychoric correlation matrix.

Internal Consistency

Conventional Cronbach's alpha was .835 (95% bootstrap CI [.792, .868]); standardized alpha based on Pearson correlations was .840. Ordinal alpha based on polychoric correlations was .892, and omega total was .893. Alpha-if-item-deleted values ranged from .821 to .833, indicating that removal of any single item did not materially improve conventional internal consistency (Table 2).

Structural Validity

The polychoric matrix was factorable, with a Kaiser–Meyer–Olkin value of .772 and a significant Bartlett test, chi-square(120) = 1437.20, $p < .001$. The first four eigenvalues were 6.18, 1.89, 1.20, and 1.05. Parallel analysis retained two factors because only the first two observed eigenvalues exceeded the corresponding 95th-percentile random values; Velicer's minimum average partial statistic was also lowest after two components were partialed (Fig. 1).

The one-factor confirmatory model did not show adequate fit: ULS chi-square(104) = 260.90, CFI = .941, TLI = .932, RMSEA = .093, and SRMR = .112 (Table 3). Standardized loadings ranged from .386 to .753, but seven communalities were below .30; item 7 had the lowest communality (.149).

Table 3
Internal Consistency and Confirmatory Model Comparisons

Analysis/model	Estimate or ULS χ^2	df	CFI	TLI	RMSEA	SRMR	Additional information
Cronbach's alpha	.835 [.792, .868]						95% bootstrap CI
Standardized alpha	.840						Pearson correlations
Ordinal alpha	.892						Polychoric correlations
McDonald's omega total	.893						One-factor polychoric solution
One-factor model	260.90	104	.941	.932	.093	.112	Loadings .386–.753
Published three-factor model	169.60	101	.974	.969	.062	.090	Highest factor r = .914

Note. N = 175. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; TLI = Tucker–Lewis index; ULS = unweighted least squares. ULS-based fit indices are descriptive because the discrepancy statistic was not mean-variance adjusted.

The published three-factor model improved fit, ULS chi-square(101) = 169.60, CFI = .974, TLI = .969, RMSEA = .062, and SRMR = .090. However, the correlation between preoccupation with thinness/weight and maintaining high glucose for weight control was .914, indicating limited discriminant separation, and SRMR remained above .08. Thus, the three-factor model was not considered unequivocally supported.

The exploratory two-factor solution accounted for the pattern indicated by the retention procedures and reduced the residual root mean square from .112 in the one-factor solution to .069. The factors correlated .394. Factor 1 was defined mainly by weight/shape concerns and compensatory diabetes-related behaviors (items 1, 8, 9, 10, 11, and 16). Factor 2 was defined mainly by dysregulated eating and diabetes-management difficulties (items 2, 3, 4, 7, 12, 13, and 14). Items 5, 6, and 15 cross-loaded at similar magnitudes, limiting a clean subscale interpretation (Table 4).

Table 4
Oblimin-Rotated Two-Factor Exploratory Pattern Matrix

Item	Abbreviated content	Factor 1	Factor 2
1	Weight loss is an important goal	**0.564**	0.031
2	Skip meals/snacks	0.285	**0.466**
3	Others say eating is out of control	0.026	**0.690**
4	Insufficient insulin after overeating	0.073	**0.603**
5	Eat more when alone	**0.340**	**0.374**
6	Difficulty losing weight and controlling diabetes	**0.333**	**0.322**
7	Avoid glucose checks when out of range	0.141	**0.333**
8	Self-induced vomiting	**0.842**	-0.036
9	Keep glucose high to lose weight	**0.838**	0.031
10	Eat until urinary ketones clear	**0.486**	0.177
11	Feel fat when taking all insulin	**0.913**	-0.101
12	Others say to care for diabetes better	0.142	**0.535**
13	Skip next insulin dose after overeating	0.230	**0.383**
14	Feel eating is out of control	-0.132	**0.888**
15	Alternate very little and very large amounts	**0.339**	**0.330**
16	Prefer thinness to good diabetes control	**0.626**	0.191

Note. Principal-axis extraction from the polychoric correlation matrix with oblimin rotation. Coefficients with absolute values ≥ .30 are bolded. Factor 1 was characterized by weight/shape concerns and compensatory diabetes-related behaviors; Factor 2 was characterized by dysregulated eating and diabetes-management difficulties. Factor correlation = .394; residual root mean square = .069.

Relations With Clinical Variables

As hypothesized, the total score correlated positively with HbA1c (Spearman rho = .379, p < .001) and BMI-for-age z score (rho = .265, p < .001). Correlations with age (rho = .074, p = .328) and diabetes duration (rho = .025, p = .738) were small and nonsignificant. Total scores did not differ by sex (Mann–Whitney p = .562).

Discussion

This study provides item-level evidence for the Brazilian Portuguese DEPS-R in adolescents receiving care for type 1 diabetes. The main finding is not a simple confirmation of a single published structure.

The total score showed good internal consistency across conventional and ordinal estimators, and it related to HbA1c and BMI-for-age in theoretically coherent directions. At the same time, the one-factor model left substantial residual correlation unexplained, and a previously published three-factor model produced a very high correlation between two factors. Parallel analysis, the minimum average partial test, and exploratory modeling instead suggested two correlated dimensions, with several cross-loading items. These results support cautious use of the total score while arguing against treating Brazilian subscales as established.

The reliability findings clarify an important distinction between coefficient types. Conventional alpha based on the observed item covariance matrix was .835, whereas ordinal alpha and omega were approximately .89. The difference is expected when skewed ordinal items are analyzed with polychoric correlations, and it illustrates why the calculation method should be named rather than reporting a single unlabeled alpha value (Dunn et al., 2014). Corrected item–total correlations were modest to moderate, but no item materially improved conventional alpha when deleted. Reliability therefore supports coherent total-score measurement; it does not resolve dimensionality or establish diagnostic accuracy.

The structural results are consistent with the heterogeneous literature. The original DEPS-R was developed as a brief screening measure, and a total score has been widely used (Markowitz et al., 2010). Three-component structures were later described in pediatric and adult samples (Pinna et al., 2017; Wisting et al., 2013, 2019). More recent Danish work found acceptable reliability but continued variability in item performance and factor structure (Abild et al., 2025, 2026). In the present sample, the published three-factor solution improved global fit relative to one factor, but the .914 correlation between two factors suggests near overlap rather than clearly distinct psychological domains. The exploratory two-factor pattern may reflect a broader separation between weight/compensatory concerns and dysregulated eating/management difficulties, yet cross-loadings and the use of the same data for exploration prevent designation of stable subscales.

Item distributions help explain this instability. Severe behaviors such as self-induced vomiting, deliberate hyperglycemia for weight loss, and insulin omission after overeating were uncommon and strongly concentrated at never. Such floor effects are clinically plausible in a general referral sample and do not make the items unimportant; rare endorsement may carry high clinical salience. Statistically, however, sparse upper categories reduce information and can magnify differences across settings, treatment technologies, age ranges, and cultural contexts. The content of item 10 has also shown weak item-level behavior in recent work (Abild et al., 2025), whereas item 7 was the least well explained by the one-factor model in the present data. These findings favor clinical review of individual responses in addition to reliance on a total score.

Positive associations with HbA1c and BMI-for-age provide limited hypothesis-based construct evidence. Similar relationships have been reported in the original and translated DEPS-R literature, although their magnitude and direction can vary by sample (Markowitz et al., 2010; Pursey et al., 2020; Wisting et al., 2013). These cross-sectional correlations should not be interpreted causally. Higher scores may reflect

insulin restriction, challenges coordinating eating and insulin, body dissatisfaction, diabetes distress, or other unmeasured psychological processes. For clinical psychologists in medical settings, a positive screen should initiate a nonjudgmental assessment of eating patterns, body image, insulin use, emotional symptoms, family support, and acute metabolic risk—not an automatic eating-disorder diagnosis.

Several limitations qualify the findings. Participants were recruited from one public referral service and were not a probability sample, limiting national generalizability. The sample was adequate for item-level analysis but too small for independent exploratory and confirmatory subsamples; the exploratory solution therefore requires external replication. No diagnostic interview, generic eating-disorder measure, test–retest assessment, or measurement-error estimate was available. Sparse categories affected several items. ULS-based model indices were used descriptively and were not mean-variance adjusted. The study also lacked sufficient power for robust measurement-invariance or differential-item-functioning analyses across sex and age groups. Finally, data collection overlapped with the COVID-19 pandemic, which may have influenced diabetes care and eating behavior.

Future multicenter studies should preregister competing models, recruit sufficiently large and diverse Brazilian samples, and use ordinal confirmatory methods with independent replication. Test–retest reliability, convergent and criterion validity against clinical interviews, and measurement invariance across sex, developmental stage, region, and treatment technology are needed. Until then, the 16-item total score is the most defensible scoring approach for Brazilian adolescents, accompanied by item-level clinical review and clear recognition that screening is not diagnosis.

Conclusion

The Brazilian Portuguese DEPS-R showed good internal consistency and clinically coherent associations with HbA1c and BMI-for-age. However, neither the one-factor nor the published three-factor structure was fully supported, and an exploratory two-factor solution contained meaningful cross-loadings. The total score may be used cautiously to support screening in adolescent diabetes care, but Brazilian subscale scores should not be recommended until the structure is replicated independently.

Declarations

Conflicts of Interest/Competing Interests

The authors declare that they have no relevant financial or non-financial interests to disclose.

Ethics Approval

The study was approved by the Research Ethics Committee of the Federal Institute of Education, Science and Technology of Ceará (approval no. 4,130,397).

Consent to Participate

Written informed consent was obtained from participants aged 18 years or older. For minors, written informed consent was obtained from a parent or legal guardian and assent was obtained from the adolescent.

Written Consent for Publication

Not applicable. No identifiable individual data or images are presented.

Use of Generative Artificial Intelligence

OpenAI ChatGPT was used to assist with drafting in scientific English. The authors assume full responsibility for the submitted work.

Note

Two factors were retained because the first two observed eigenvalues exceeded the 95th percentile of eigenvalues from 5,000 random data sets (N = 175; 16 variables).

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Author Contribution

Conceptualization: Maria da Conceição dos Santos Oliveira Cunha, Thereza Maria Magalhães Moreira, Maria Veraci Oliveira Queiroz. Methodology: Maria da Conceição dos Santos Oliveira Cunha, Marília de Sousa Gonçalves, Márcio Flávio Moura de Araújo, Thereza Maria Magalhães Moreira. Data curation and investigation: Maria da Conceição dos Santos Oliveira Cunha, Marília de Sousa Gonçalves. Formal analysis: Maria da Conceição dos Santos Oliveira Cunha, Márcio Flávio Moura de Araújo, Thereza Maria Magalhães Moreira. Writing—original draft: Maria da Conceição dos Santos Oliveira Cunha, Márcio Flávio Moura de Araújo, Thereza Maria Magalhães Moreira. Writing—review and editing: all authors. Supervision: Maria Veraci Oliveira Queiroz, Thereza Maria Magalhães Moreira, Márcio Flávio Moura de Araújo. All authors must review and approve the final contribution statement before submission.

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Availability of Data and Material

The de-identified item-level data are not publicly available because the original consent process did not include public data release. A minimal de-identified data set may be made available to qualified researchers subject to approval by the responsible ethics committee and execution of a data-use agreement.

Code Availability

The analysis code may be made available to qualified researchers subject to approval by the responsible ethics committee and execution of a data-use agreement.

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Figures

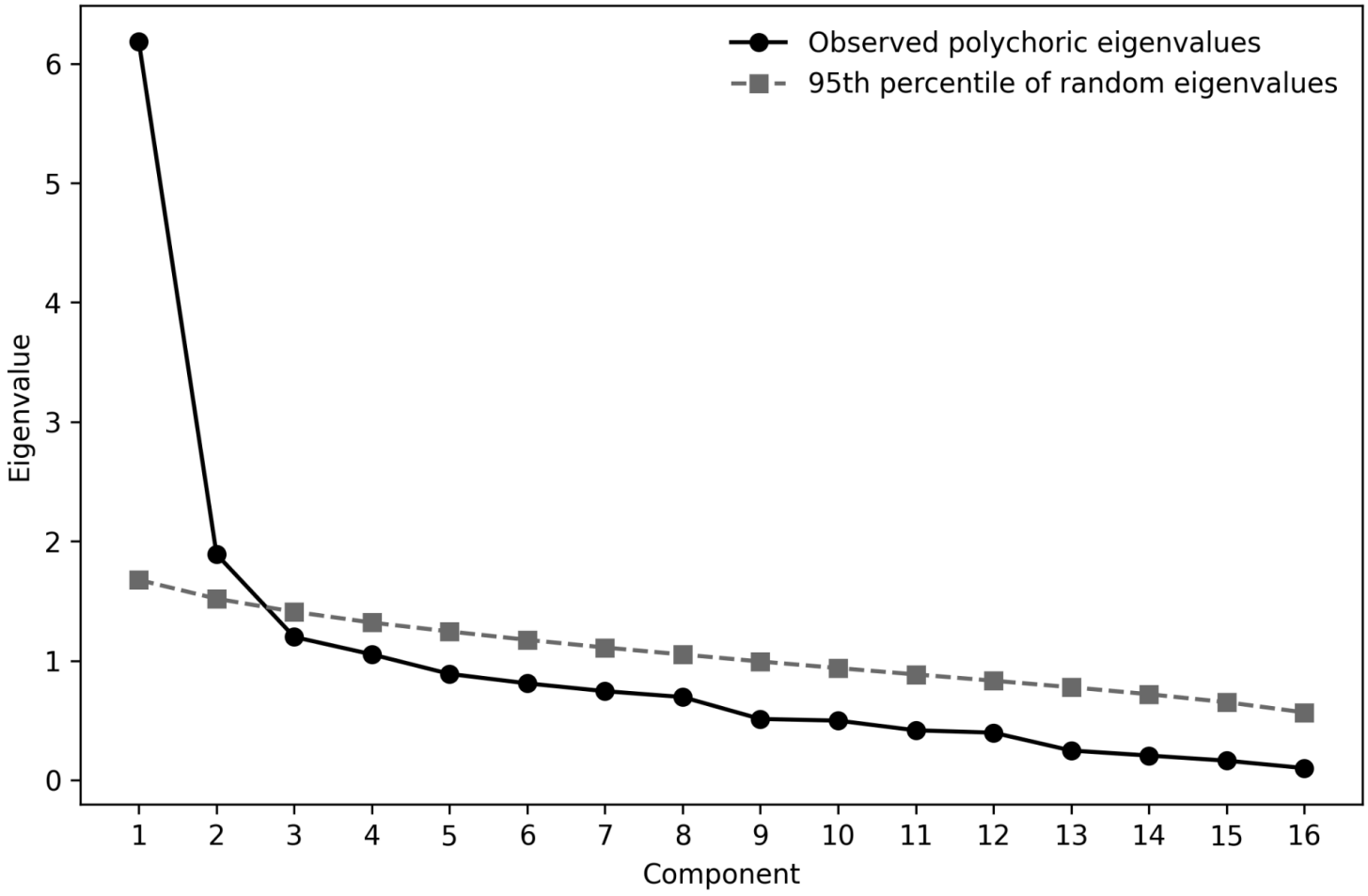


Figure 1

Parallel Analysis of the DEPS-R Polychoric Correlation Matrix