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Perceived stress in parents of children with neurodevelopmental disorders: psychometric properties of the stress measurement scale in the Moroccan dialect

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Abstract
This research aims to evaluate the psychometric properties of the stress scale among parents of children with neurodevelopmental disorders (NDD) by studying the validity, reliability, and cultural adaptation of this scale in the Moroccan context. The sample consists of 57 parents (both mothers and fathers) of children with NDD in different regions of Morocco; it is a self-administered questionnaire designed to assess "the degree to which individuals perceive situations in their lives as stressful". This study showed that by removing the items Q4 and Q5, Cronbach's α increases to 0.810, strengthening the reliability of the scale. Regarding the adaptation of the Perceived Stress Scale (PSS) scale to the Moroccan context, the adjustment indices revealed a moderate fit of the model to the data**.** Therefore, the results confirm the validity of the 8-item PSS scale in the Moroccan context. In order to improve the accuracy of the measurements, future research could focus on the integration of physiological biomarkers; an approach combining these two aspects could provide a more comprehensive and nuanced assessment of the stress response, promoting more targeted and effective interventions in the field of mental health and well-being.

Introduction

Stress is a central component of the emotional reactions and psychological responses that individuals develop to the situations and demands of daily life, which can become chronic if poorly managed or persistent.[1] Parenting is often perceived as both a rewarding and demanding experience, with parental stress appearing more as the norm than the exception.[2] Parental stress is mainly influenced by the person responsible for the primary care and education of the children, as well as by factors such as the parents' work, their mental health, and the child's social, cognitive, and physical development.[2] His notion is particularly important in contexts of increased vulnerability, such as parents of children with neurodevelopmental disorders (NDD) like autism or attention deficit disorder with or without hyperactivity (ADHD).[3,4] Stress is often exacerbated by the specific challenges of educating, caring for, and supporting these children.[4,5]

Parental stress results from an imbalance between the perceived demands of parenthood and the resources available to cope with them.[6] Coping is defined as the cognitive and behavioral efforts made to manage the concrete demands that are perceived as stressful by the individual.[7] Thus, even when the demands are high, the parents' ability to cope with the challenges can reduce the impact of parental stress on their well-being. Among the many factors (relating to the parent, the child, and the social context) that make up the conceptual network of parental stress,[8] a transactional model has, over time, demonstrated the relationship between parental stress and behavioral problems. High parental stress has been shown to exacerbate child behavioral problems.[9] The findings are broadly similar for mothers and fathers.[10]

Several studies of parents of children with different types of NDD have focused on parental stress levels that are higher than those of parents of children with major depressive disorder.[11] Although the highest levels of parental stress are reported by parents of children with autistic spectrum disorder (ASD) or ADHD, parents of children with ASD or personality disorder also report higher levels of parental stress than parents of children without NDD.[11] Thus, parental stress in mothers and fathers is associated with ADHD symptoms in their adolescent children, as well as with their own symptoms of depression.[12] Moreover, ADHD symptoms in mothers are also associated with their own chronic fatigue syndrome and parental stress.[12] Researchers have therefore stressed the importance of taking parents' needs and stress levels into account in the assessment and treatment processes.[3]

These observations highlight the importance of taking the parents' needs and stress levels into consideration in diagnostic assessments and therapeutic interventions for their children. It is therefore crucial to validate reliable and appropriate instruments to assess perceived stress, especially in specific linguistic and cultural contexts such as the Moroccan dialect. This study aimed to evaluate the psychometric properties of the stress measurement scale among parents of children with NDD, in the Moroccan dialect. It was assumed that the Perceived Stress Scale (PSS) would also have good psychometric properties in the Moroccan dialect. Specifically, it was expected that this would manifest itself in PSS scores among parents of children with NDD compared to parents from the general population.

Materials and Methods

This is a quantitative cross-sectional study aimed at evaluating the psychometric properties of a scale for measuring perceived stress adapted to the Moroccan dialect, among parents of children with NDD. Specifically, this study focuses on the validity, reliability, and cultural adaptation of the scale in a Moroccan context. The target population of this study consists of parents of children aged 3 to 18 years of age, diagnosed with NDD (including autism, ADHD, learning disabilities, *etc*.). Participants were recruited from different regions of Morocco, and the sample consisted of 57 parents (mothers and fathers) selected through a stratified random sampling procedure to reflect the different socio-demographic categories of parents of children with NDD.

The measurement instrument used is an adapted version of the PSS translated and validated in the Moroccan dialect (Darija). The scale consists of 10 items (Q1-Q10) measuring the intensity and frequency of feelings of perceived stress on a five-point Likert scale, ranging from "Never" to

"Always". The items cover aspects such as emotional overload, uncertainty about the future, and parenting concerns. Cultural adaptation was carried out by a team of linguists and psychologists to ensure that the terms and questions were appropriate and understandable in the Moroccan context.
The data collected was analyzed using statistical methods. Exploratory factor analysis was used to examine the factor structure of the scale and verify its relevance to the target population. The calculation of Cronbach's α allowed the assessment of the internal consistency of the scale and ensured its reliability as a measure of perceived stress. Convergent validity analysis was used to test the correlation between the PSS scores and other standardized measures of stress, such as the Parental Stress Scale. Normality tests (Kolmogorov-Smirnov) were used to check the distribution of perceived stress scores in the sample. Descriptive statistics (means, standard deviations) were carried out to characterize the sample in terms of socio-demographic variables (age, gender, and socio-economic status).

Results

The social demographics of the participants

Descriptive statistics for the social demographic variables studied present several interesting insights into the study population (Table 1). Regarding the number of children, the mean was 1.96, indicating that parents had an average of about two children. The median was also 2, indicating that half the respondents had two children or fewer. Variability in the number of children was low, with a standard deviation of 0.755, and observed values ranging from 1 to 3 children. The distribution of the number of children was almost symmetrical, as indicated by a very low coefficient of skewness of 0.0586. However, the negative kurtosis of -1.21 suggested a slightly flatter distribution, with fewer extreme values compared to a normal distribution. The Shapiro-Wilk normality test indicated that the distribution was not normal ($p<0.001$).
The mean age of the children at diagnosis was 6.53 years, with a median of 6 years, indicating that the majority of children were diagnosed around this age. The standard deviation was 1.21, reflecting moderate variability in children's ages. The ages ranged from 4 to 10 years, and the distribution was slightly skewed to the right (skewness coefficient of 0.685), suggesting that more children were diagnosed at younger ages. The positive kurtosis of 0.801 indicated a concentration of values around the mean but with a slightly narrower tail than that of a normal distribution. Similar to the previous variable, the Shapiro-Wilk test showed a non-normality of the distribution ($p<0.001$).
The gender distribution of participants in the sample revealed that almost all parents were female. In fact, 80% of the participants were women, and 20% were men. This distribution shows that the majority of respondents were women.
The frequencies of the gender variable in the study sample revealed that 36.8% of participants were female, while 63.2% were male (Figure 1). In terms of cumulative percentages, 36.8% of the participants were female, and, if the male participants are included, the cumulative percentage reaches 100%. The sex ratio, calculated by comparing the number of male and female participants, was 1.71, which means that there were approximately 1.71 males for each female in this sample.

Psychometric properties

Cronbach's α is a measure commonly used to evaluate the internal consistency of a measurement scale. In this analysis, we examined Cronbach's α for a PSS (Table 2), with an initial value of 0.650. We also explored the impact of deleting certain items on this value. The initial Cronbach's α for the full scale was 0.650, indicating moderate internal consistency. Ideally, a value greater than 0.7 would be desirable to ensure greater reliability. Removing items Q4 and Q5 significantly increased Cronbach's α, suggesting that these items were negatively correlated with the total scale score. After deleting items Q4 and Q5, we recalculated Cronbach's α to assess the impact of these deletions on the internal consistency of the PSS. The initial Cronbach's α for the full scale was 0.650. After deleting items Q4 and Q5, Cronbach's α reached 0.810, indicating a significant improvement in the

internal consistency of the scale. After adjusting the PSS by deleting items Q4 and Q5, we recalculated the descriptive parameters for the Moroccan version of the eight-item scale.

Descriptive statistics for the new version of the PSS (8 items) revealed a relatively normal distribution of scores, with improved internal consistency (Cronbach's α=0.810). On average, participants showed a moderate level of perceived stress (Table 3), with a mean score of 24.0. The median, being slightly higher at 24.5, indicates that half the participants had scores above 24.5, suggesting that the distribution of scores was relatively symmetrical. The standard deviation of 5.54 indicates a moderate variation of scores around the mean, meaning that levels of perceived stress differ significantly between participants, but only moderately. The scores ranged from 10 to 38, indicating a wide range of perceived stress levels in the sample.

In terms of skewness (Table 3), the coefficient of 0.132 suggests a slightly positive skewness, indicating a slightly right-skewed distribution. However, this skewness is modest, meaning that the distribution of scores is close to normal. Furthermore, a kurtosis of 0.306 indicates a slightly platykurtic distribution, which means that the curve of the score is slightly less sharp than that of a normal distribution, with less pronounced tails. In summary, these results suggest that the revised PSS has a score distribution that remains relatively normal and balanced and that it can be reliably used to assess stress in this population.

The Bartlett test of sphericity was used to determine whether the correlations between items in a set of variables were strong enough to proceed to factor analysis. If the test statistic is significant ($p<0.05$), the data are suitable for factor analysis (Table 4). The Bartlett test statistics were significantly high ($p<0.001$), indicating that the correlations between the variables were strong enough for factor analysis to be valid.

In other words, the data indicated significant correlations between the variables, justifying the application of factor analysis to explore the underlying structure of the PSS items. Component contributions showed how each item contributed to each factor extracted in the factor analysis. The 'varimax' rotation was used to maximize the variance of the factor loadings in order the interpretation of the factors clearer.

Item Q1 (load of 0.754 on component 1) had a strong contribution to component 1, with a load of 0.754, suggesting that it was strongly related to this component. Item Q2 (load of 0.905 on component 1) showed a very strong contribution to the first component, with a load of 0.905, indicating that it was very well explained by this component. Item Q3 (load of 0.819 on component 1) also had a high weight on the first component (0.819), indicating that it was well represented by this component. Item Q6 (load of 0.742 on component 1), on the other hand, had a moderate contribution to the first component (0.742) but was still significant.

Item Q7 (load of 0.996 on component 1) had an extremely high loading (0.996) on the first component, indicating that it was almost perfectly represented by this component. Item Q8 (load of 0.332 on component 1, load of 0.890 on component 2) had a low loading on the first component (0.332) and a very high loading on the second component (0.890). This suggests that this item was better represented by the second component. Item Q9 (load of 0.710 on component 1) had a moderate to high loading (0.710) on the first component. Item Q10 (load of 0.719 on component 1) had a moderate loading on the first component (0.719), indicating a significant contribution to this component.

The results of Bartlett's sphericity test confirm that factor analysis is appropriate for the data. The 'varimax' rotation extracted factors where some items, such as Q7, Q2, and Q3, had very high loadings on the first component, while item Q8 stood out with a lower loading on the first component and a high loading on the second component. This suggests that the items were well distributed across the various components extracted, offering a factor structure that warrants further exploration for further interpretation.

The adjusted measures of the 8-item PSS, adapted to the Moroccan context, show adjustment indices, indicating a moderate adaptation of the model to the data (Table 5). The 90% confidence interval for the root mean square error of approximation (RMSEA) ranged from 0.150 to 0.257, suggesting an

acceptable adjustment but can be improved, as an RMSEA of less than 0.05 is generally sought for a good fit. The Comparative Fit Index (CFI) is 0.855, which is relatively good, though a value above 0.90 is ideal. The Tucker-Lewis Index (TLI) was measured at 0.797, slightly below the recommended threshold of 0.80, indicating that the model has an acceptable fit but could be improved. Finally, RMSEA was 0.202, which is fairly high, as lower values are generally preferred for an optimal fit. In sum, although the indices suggest a reasonable model fit, improvements could be made to optimize the scale's adaptation to the Moroccan context.

Discussion

Stress has long been an important concept in health sciences research due to its association with numerous pathologies, such as cancer, diabetes, cardiovascular disease, asthma, and rheumatoid arthritis.[12,13] The different approaches to assessing stress in research can be grouped into three broad perspectives: i) the environmental perspective, which focuses on stressors or life events; ii) the psychological perspective, which measures subjective appraisal of stress and affective reactions; and iii) the biological perspective, which assesses the activation of physiological systems involved in the stress response.[12,13]

PSS is one of the most widely used tools for measuring psychological stress.[14] It is a self-administered questionnaire designed to assess "the degree to which individuals perceive situations in their lives to be stressful".[12,14] The items on the PSS scale measure the extent to which individuals perceive their lives as unpredictable, uncontrollable, and overwhelming over the past month, taking a general approach, without focusing on specific events.[12,15]

There are several versions of the PSS. The original version is a 14-item scale (PSS-14) developed in English,[14] consisting of 7 positive and 7 negative items, measured on a 5-point Likert scale. Then, 5 years after the introduction of the PSS-14, its items were reduced to 10 using factor analysis on a sample of 2387 American residents.[16] An abbreviated 4-item version has also been developed for situations requiring a rather concise tool, or for telephone interviews.[12,14] PSS has been translated into 25 languages, according to Cohen's Laboratory for the Study of Stress, Immunity and Disease (2012). The Moroccan dialect version of the PSS has been validated with very satisfactory psychometric properties.[17]

In this study, the results confirm that the PSS scale accurately reflects variations in parental stress, even in different cultural contexts. For example, in the Swedish context, previous research has shown that the PSS is able to capture variations in parental stress,[18] which is also confirmed in our study. The Cronbach's α coefficient was 0.650, indicating moderate internal consistency. Although a coefficient greater than 0.7 is recommended for optimal reliability, our analysis shows that by deleting items Q4 and Q5, Cronbach's α reached 0.810, increasing the reliability of the scale. This confirms that certain items can be negatively correlated with the total scale score.

Regarding the adaptation of the PSS scale to the Moroccan context, the fit indices revealed a moderate fit of the model to the data. For example, the RMSEA confidence interval ranged from 0.150 to 0.257, indicating an acceptable fit, although there is room for improvement to optimize this fit. Similarly, the CFI of 0.855 and TLI of 0.797 were relatively good, but slightly below ideal thresholds. The two-factor model, with the first factor reflecting parental stress and distress, and the second reflecting lack of parental rewards and role satisfaction, is consistent with structures observed in other studies of PSS.[12,18]

A study cited here, validating the translation of the PSS scale into the Moroccan dialect, revealed satisfactory psychometric properties, with good internal reliability (α=0.78 for the original version and 0.74 for the Arabic version) and adequate reproducibility (ICC=0.87).[17] This version showed a significant correlation with stressful events, especially with the Stressful Life Events Rating Scale, despite the low correlations observed.[17] This may be attributed to the ability of some individuals to adapt to stressful events in spite of their high frequency.

The factorial structure of the PSS, which distinguishes a first-factor grouping negative items (perceived stress) from a second-factor grouping positive items (coping),[13] is also confirmed in this

study. This bifactorial model has been widely observed in PSS translation and validation studies, supporting its robustness and ability to differentiate between perceived stress and coping.[13] This bifactorial model differs from our unidimensional model, but the moderate adjustments observed suggest that the scale remains a valid and reliable tool for measuring parental stress. There is potential for improvement in its application and interpretation, particularly by examining its two subscales: one reflecting negative aspects of stress and the other coping skills.

Conclusions

Although the two-factor structure of the PSS is dominant in most studies, some research has explored alternative approaches. For example, the study by Mitchell *et al.* (2008) proposed a unidimensional model, but this was based on a small sample size, which limits the generalizability of their findings. This difference between the models highlights the need for further exploration of the underlying structures to ensure a more in-depth understanding of the mechanisms of stress perception.

To improve measurement accuracy, future research could focus on integrating physiological biomarkers, such as cortisol, a hormone widely recognized for its role in stress regulation. The integration of such biological data would not only enable assessment of the validity of the PSS criteria more objectively, but also better grasp the interactions between psychological perceptions of stress and physiological responses. An approach combining these two aspects could yield a more comprehensive and nuanced assessment of the stress response, thus promoting more targeted and effective interventions in the field of mental health and well-being.

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Table 1. Distribution according to social demographic parameters

	Number of children	Child age at the time of diagnosis
N	57	57
Mean	1.96	6.53
Median	2	6
Standard Deviation	0.755	1.21
Minimum	1	4
Maximum	3	10
Skewness coefficient	0.0586	0.685
Standard error asymmetry	0.316	0.316
Kurtosis	-1.21	0.801
Standard-error Kurtosis	0.623	0.623
Shapiro-Wilk's W	0.809	0.888
Shapiro-Wilk p-value	<0.001	<0.001

Table 2. Distribution according to Cronbach's index.

Items	Statistics	
	Before deleting the items	After deleting the items
Q1	0.584	0.775
Q2	0.532	0.739
Q3	0.550	0.761
Q4	0.739	Deleted
Q5	0.711	Deleted
Q6	0.594	0.782
Q7	0.653	0.843
Q8	0.625	0.821
Q9	0.588	0.785
Q10	0.592	0.781
Cronbach's α	0.65	0.81

Table 3. Distribution according to the position and dispersion parameters of the PSS 8-DM scale.

Descriptive parameters	Values
Mean	24.0
Median	24.5
Standard deviation	5.54
Minimum	10
Maximum	38
Skewness coefficient	0.132
Standard error asymmetry	0.330
Kurtosis	0.306
Standard-error Kurtosis	0.650

Table 4. Factor analysis of the PSS 8-DM scale.

Contributions of the components		
	Component	
	1	**Unicity**
Q1	0.754	0.431
Q2	0.905	0.182
Q3	0.819	0.329
Q6	0.742	0.450
Q7	-	0.996
Q8	0.332	0.890
Q9	0.710	0.496
Q10	0.719	0.483

The 'varimax' rotation was used

Table 5. Fit index in our model.

			CI 90% of RMSEA	
CFI	**TLI**	**RMSEA**	**Lower**	**Upper**
0.855	0.797	0.202	0.150	0.257

CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; CI, confidence interval; RMSEA, root mean square error of approximation.

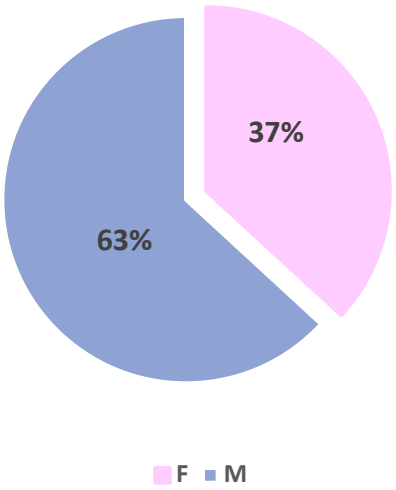

Figure 1. Distribution of children according to gender. F, female; M, male.