diabetology

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Psychometric Properties of the Hypoglycemia Fear Survey—Parents (HFS-P) in the Portuguese Context

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Abstract

Background/Objectives: Hypoglycemia occurs when blood glucose levels drop significantly below the normal range leading to unpleasant symptoms and a greater risk of acute complications. Fear of hypoglycemia (FH) is a conditioned psychological response to hypoglycemia frequently experienced by people with type 1 diabetes (T1D) and their loved ones. The present study aimed to examine the psychometric properties of a Portuguese translation of the Hypoglycemia Fear Survey—Parents (HFS-P) for the parents of youths with T1D. **Methods:** The sample consisted of 102 parents (M = 44.58 years old; SD = 5.01; mothers = 92.2%) of youths with T1D (8 to 17 years of age; M = 12.67; SD = 2.58). Confirmatory Factor Analysis (CFA) and convergent validity were performed to examine the factor structure and the construct validity of the HFS-P. **Results:** CFA supports a refined two-factor 18-item version of the HFS-P. The results indicate good psychometric properties (χ^2 [129] = 220.47.; $p \leq 0.001$; χ^2/DF = 1.71; RMSEA = 0.08; SRMR = 0.07; CFI = 0.93; TLI = 0.91; GFI = 0.93) along with good to excellent internal consistency coefficients (behavior subscale: $\alpha = 0.81$, total: $\alpha = 0.93$, and worry: $\alpha = 0.94$). **Conclusions:** Our Portuguese version of the HFS-P appears reliable for assessing FH in parents of youths with T1D, and is ready for use in clinical research and to evaluate psychological interventions targeting parental FH in the Portuguese context.

Keywords: fear of hypoglycemia; youth; type 1 diabetes; Portuguese context

Academic Editor: Peter Clifton

Received: 3 June 2025
Revised: 7 July 2025
Accepted: 17 July 2025
Published: 28 July 2025

Citation: Costa, V.; Patton, S.R.; do Vale, S.; Sampaio, L.; Limbert, C.; Brandão, T. Psychometric Properties of the Hypoglycemia Fear Survey—Parents (HFS-P) in the Portuguese Context. *Diabetology* **2025**, *6*, 71. https://doi.org/10.3390/diabetology6080071

1. Introduction

Hypoglycemia is the term used for blood glucose levels ≤ 70 mg/d, and it is a common acute complication in individuals living with type 1 diabetes (T1D) [1,2]. Hypoglycemia can occur at any time of the day. It is caused by a lack of adequate food ingestion, excessive insulin administration, or physical activity that is highly vigorous and/or performed for a

long duration. The symptoms of hypoglycemia mainly manifest as sweating, confusion, shakiness, and dizziness [3]. However, persistent hypoglycemia can lead to both short-term symptoms as well as long-term complications, such as cerebral damage, impaired symptom awareness, vision loss, and cardiac problems [4,5]. Additionally, severe hypoglycemia episodes, if not promptly prevented and/or treated (i.e., carbohydrate ingestion and/or glucagon administrated intramuscularly or nasally), can result in seizures, a loss of consciousness, and death [6,7]. Hypoglycemic symptoms present similarly across different age groups, though the accurate recognition of symptoms may be more challenging in pediatrics (i.e., young children and youth) [8,9]. Moreover, lower levels of T1D treatment engagement among some youths and increased vulnerability associated with the nighttime represent crucial areas of concern and fear for parents and children with T1D, reinforcing the importance of strict T1D management and stable blood glucose levels (i.e., optimal and recommended clinical targets for glycated hemoglobin levels and time in range) [10–13].

Fear of hypoglycemia (FH) is a conditioned psychological response to hypoglycemia experienced worldwide by individuals with T1D and their loved ones [14,15]. For youths with T1D, their parents are vulnerable to FH because they frequently assume primary responsibility for their child's daily T1D management [16]. Indeed, among parents, their fear response can lead to their adoption of maladaptive behaviors and strategies to prevent hypoglycemic episodes, including maintaining higher blood glucose levels and/or reducing insulin dosages [17,18]. The data show an association between parental FH and youths' glycemic levels [19–21]. Furthermore, there are also data linking FH in the parents of youths with T1D to other psychological outcomes, such as diabetes distress, parenting stress and depression [22]. Thus, it is possible that monitoring and addressing parents' FH could potentially contribute to improving both their mental health and the management of their child's T1D [23–25].

The Hypoglycemia Fear Survey (HFS) is the most common and established instrument for assessing FH in adults with T1D. It comprises a two-factor structure, behavior and worry, and includes 33 items [26]. A revised version, HFS-II, updated the wording for several items, while maintaining the original number of items and the two-factor structure [27]. Then, building on the original HFS, the researchers validated adaptations of the HFS, including a version targeting the parents of youths with T1D (26-item HFS-P), a version specifically addressing the nighttime fear of hypoglycemia (34-item HFS-P-NF), a version targeting parents' young children (26-item HFS-P-YC) [28–30], and a version targeting the youths themselves (25-item HFS-C) [31].

Focusing specifically on the HFS-P, validation studies have confirmed its psychometric properties [24,31–34] and provide data supporting the original two-factor structure (viz., worry and behavior) [32–34], as well as alternative models, including a three-factor solution [24,33] and a four-factor solution [31]. However, beyond the validation efforts conducted in the United States, Italy, Norway, and Greece, it remains of significant importance to translate and validate the HFS-P for other languages and cultures because this measure is the most widely used tool available to evaluate FH in the parents of youths with T1D. To the best of our knowledge, there are no alternative measures available to assess parental fear of hypoglycemia.

Hence, there are three aims for the present study: First, to evaluate the factorial structure of a Portuguese version of the HFS-P through a Confirmatory Factor Analysis (CFA) conducted within a Portuguese parent population; second, to evaluate the internal consistency of the instrument; and third, to examine the convergent validity of the Portuguese HFS-P by analyzing its correlations with diabetes distress, anxiety, depression, and stress.

2. Materials and Methods

2.1. Participants

Though we acknowledge that the term *parent* may not capture all caregiving relationships, for simplicity, we use *parent or parents* throughout this manuscript to describe participants. Our study inclusion criteria restricted eligibility to parents of youths aged 8 to 17 years. Additionally, parents had to self-identify as the primary caregiver involved in their child's T1D care, to show they did not have any diagnosed psychopathology, and to show that their child had no comorbid severe chronic disease.

2.2. Measures

2.2.1. Sociodemographic Data

The sociodemographic questionnaire collected information on parent's age, employment and marital status, and residential district and area. For the youths, data on age, gender, and T1D duration were gathered. Additionally, supplementary questions were administered to ensure compliance with this study's inclusion criteria.

2.2.2. Hypoglycemia Fear Survey—Parents

Hypoglycemia Fear Survey—Parents [28] is a self-report questionnaire consisting of 26 items, divided into two subscales: behavior (items 1–11) and worry (items 12–26). Each item was rated on a 5-point Likert scale ranging from 0 = Never to 4 = Almost always. The survey aimed to evaluate parents' FH in the context of different situations involved in managing their child's T1D. The behavior subscale evaluates parents' avoidance behaviors aimed at preventing low blood glucose episodes—Item example: "*Allow blood sugar to be a little high to be on the safe side*"—while the worry subscale measures the extent of parental concern about the occurrence of hypoglycemia events—Item example: "*Child having seizures or convulsions*". Total and subscales scores were calculated by summing the corresponding items: HFS-P total (in the range of 0–104), behavior (ranging from 0 to 44), and worry (ranging from 0 to 60).

Previously, a Cronbach's α for the total score has not been reported. For the subscales (behavior and worry), Cronbach's α scores were 0.72 and 0.88 [28].

2.2.3. Diabetes Distress

Problem Areas in Diabetes—Parent Revised (PAID-PR) version [35] is an 18-item self-report instrument designed to assess diabetes-specific emotional distress experienced by the parents of children and adolescents with T1D. Items are rated on a 5-point Likert scale ranging from 0 (Agree) to 4 (Disagree), with higher total scores demonstrating greater perceived distress (items must be reverse scored and converted to a 0–100 scale). PAID-PR has two factors: Immediate Burden and Theoretical Burden. We used a validated Portuguese version of PAID-PR [36], which has previously shown evidence of good internal consistency (Cronbach's α of 0.88 for the total score).

2.2.4. Depression, Anxiety, and Stress

Depression Anxiety Stress Scales (DASS-21) [37] is a 21-item instrument developed to assess the intensity of depression, anxiety, and stress symptoms. Items are rated on a 4-point Likert scale ranging from 0 (does not apply to me at all) to 3 (applies to me most of the time). Lower scores indicate a reduced presence of each respective emotional state. We used a validated Portuguese version [38], which has previously shown evidence of strong internal consistency (Cronbach's α values of 0.88 [depression], 0.87 [anxiety], and 0.91 [stress]).

2.3. Procedure

2.3.1. Ethics and Data Collection

The present study was approved by the Ethical Committee of ISPA—University Institute (Reference: D-080-4-24). Data collection was carried out between April and May of 2024, using an online survey (i.e., Google Forms). The inquiry was principally distributed via Facebook groups for the parents of youths with T1D. Participation in this study was voluntary, and all parents provided informed consent. Parents did not receive any kind of incentive to participate and were free to withdraw from this study at any time without any penalty.

2.3.2. Translation Process of HFS-P

According to the published guidelines [39,40], structured procedures are required to ensure cultural and linguistic accuracy when translating psychological measures. To adapt the HFS-P for the Portuguese context, two bilingual translators independently translated the questionnaire, after which the research team debated any discrepancies to produce a preliminary version. We next had two native English speakers who were fluent in Portuguese each perform a back-translation of the preliminary version, and we compared the resulting back-translations to harmonize them and determine a pre-final version. To assess the relevance of the translation, we conducted cognitive debriefing interviews with a convenience sample of three Portuguese-speaking participants from Lisbon. The sample included one emergent adult (i.e., a male with T1D) and two adults (i.e., a male parent of a child without T1D and a female parent of a child with T1D). Based on their detailed feedback, we made minor revisions to the pre-final version to enhance the instrument's clarity and cultural appropriateness, ultimately leading to the final Portuguese version of the HFS-P evaluated in the present study.

2.4. Data Analysis

2.4.1. Descriptive Statistics and Normality Assessments

To assess the normality of the data distributions, we examined skewness and kurtosis and used the Shapiro–Wilk test. These analyses were conducted using SPSS version 30. As recommended by a previous investigation [41], the conventional range between −1 and +1 for skewness and kurtosis was applied.

2.4.2. Factorial Validity and Fit Indices

To examine the factorial structure of the Portuguese HFS-P version, a Confirmatory Factor Analysis (CFA) was conducted using the JASP software version 0.18.3.0. We assessed the maximum likelihood estimation for parameter estimation and the model's goodness of fit. These indices include the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Standardized Root Mean Square Residual (SRMSR), Goodness-of-Fit Index (GFI), Chi-square divided by degrees of freedom (χ^2/DF), and Root Men Square Error of Approximation (RMSEA). We evaluated these fit indices using standard thresholds (CFI $\geq$ 0.90; TLI $\geq$ 0.90; SRMR $\leq$ 0.08; GFI $\geq$ 0.95; RMSEA $\leq$ 0.08) [42,43]. Furthermore, we removed factor loadings below 0.30 in accordance with the published recommendations [44,45].

2.4.3. Reliability Analysis

To analyze the internal consistency of the instrument, we estimated reliability coefficients using Cronbach's α and McDonald's ω. We applied the following published thresholds [46,47] to interpret our results: moderate (α, $\omega \geq 0.60$), acceptable (α, $\omega \geq 0.70$), good (α, $\omega \geq 0.80$), or excellent (α, $\omega \geq 0.90$).

2.4.4. Convergent Validity Analysis

To verify convergent validity, we used Spearman correlations to assess the associations between parental FH, diabetes distress (only total score), and their anxiety, depression, and stress levels. We used the published criteria to interpret these associations as follows: weak (0.10–0.29), moderate (0.30–0.49), strong (≥0.50–0.79), or very strong (≥0.80–1.0) [48,49].

3. Results

3.1. Sample

The final sample consisted of 102 parents of youths with T1D. Parents had a mean age of approximately 45 years, and most were employed, married/in a civil union, and residing in an urban area (e.g., Lisbon, Porto, Braga, Setúbal, Aveiro, and Coimbra). Youths were about 12 years old, had an average T1D duration of about 6 years, and most reported using an insulin pump. Parents' mean item score on the HFS-P corresponded to the response "sometimes" (see Table 1).

Table 1. Principal characteristics of the study population.

Variable	Parents	Children
T1D Duration		M = 5.92; SD = 3.52
T1D Treatment		Insulin Pump (68.6%) and Insulin Pens (31.4%)
Districts	Lisbon (20.6%), Porto (19.6%), Braga (8.8%), Setúbal (7.8%), Aveiro (5.9%), and Coimbra (4.9%)	Lisbon (20.6%), Porto (19.6%), Braga (8.8%), Setúbal (7.8%), Aveiro (5.9%), and Coimbra (4.9%)
Type of Residence Area	Urban area (77.5%) and Rural area (20.6%)	Urban area (77.5%) and Rural area (20.6%)
Sex	Female (92.2%) and Male (7.8%)	Female (48%) and Male (52%)
Age	M = 44.58 years old SD = 5.01	M = 12.67 years old; SD = 2.58
Professional status	Employed (85.5%),	
Marital Status	Married/in a civil union (81.4%)	
Fear of Hypoglycemia	M = 45.70; SD = 15.83 (Total score) M = 1.76; SD = 0.60 (Item score)	

3.2. Descriptive Data Analysis

Table 2 displays the distributional parameters and demonstrates that some items exhibit skewness (i.e., 3.85) and kurtosis (i.e., 15.64) values beyond the acceptable thresholds for normality (i.e., range between −1 and +1). Additionally, the Shapiro–Wilk test yielded statistically significant results ($p < 0.001$) across all items, thereby confirming a violation of the assumption of univariate normality.

3.3. Twenty-Six-Item HFS-P—CFA and Reliability

A CFA using all 26 items from the Portuguese HFS-P [28] was conducted first. The findings indicate that the two-factor structure for the 26-item Portuguese version yields a poor fit to the data: χ^2 [298] = 502.57; $p \leq 0.001$; χ^2/DF = 1.69; RMSEA = 0.08; SRMR = 0.09; CFI = 0.85; TLI = 0.83; GFI = 0.98. However, the Cronbach's alpha results suggest excellent internal consistency for the overall scale ($\alpha = 0.90$) and the worry subscale ($\alpha = 0.94$), and acceptable consistency for the behavior subscale ($\alpha = 0.70$). Similarly, using McDonald's omega, the total scale exhibited excellent internal consistency ($\omega = 0.90$), the worry subscale demonstrated excellent internal consistency ($\omega = 0.95$), while the behavior subscale demonstrated moderate internal consistency ($\omega = 0.68$). A factor loadings analysis revealed that eight items associated with the behavior factor did not meet the established threshold of 0.30 and were therefore excluded from the model (items 1 = 0.28; 2 = 0.18;

5 = 0.28; 6 = 0.20; 8 = 0.19; 9 = 0.16; 10 = 0.27, and 11 = 0.14). Furthermore, modification indices suggested the inclusion of error correlations between the following item pairs: 18–19; 14–21; 20–21; 15–21; 18–23. These error covariances may be justified based on the thematic similarities of the items (e.g., items 18 and 19: behavioral manifestations of hypoglycemia; items 14, 20, 21, and 15: contexts and situations increased vulnerability to hypoglycemia; items 18 and 25: potential severe repercussions of hypoglycemia).

Table 2. Descriptive statistics and normality of the 26-item HFS-P.

Items	M	SE	SD	Sk	SE	K	SE	SW
1	0.96	0.11	1.10	1.00	0.24	1.00	0.47	0.79 *
2	3.17	0.11	1.11	−1.14	0.24	0.19	0.47	0.75 *
3	1.32	0.09	0.91	0.50	0.24	0.59	0.47	0.86 *
4	0.98	0.09	0.92	0.81	0.24	0.66	0.47	0.83 *
5	2.32	0.12	1.19	−0.08	0.24	−1.02	0.47	0.90 *
6	2.67	0.13	1.30	−0.60	0.24	−0.79	0.47	0.85 *
7	1.00	0.09	0.93	0.67	0.24	−0.05	0.47	0.85 *
8	3.91	0.03	0.32	−3.85	0.24	15.64	0.47	0.30 *
9	2.35	0.12	1.16	−0.18	0.24	−0.63	0.47	0.90 *
10	3.07	0.10	1.01	−0.79	0.24	−0.26	0.47	0.82 *
11	2.88	0.11	1.14	−0.75	0.24	−0.24	0.47	0.84 *
12	1.92	0.11	1.12	0.33	0.24	−0.60	0.47	0.90 *
13	1.35	0.12	1.21	0.63	0.24	−0.48	0.47	0.87 *
14	1.12	0.14	1.41	0.94	0.24	−0.52	0.47	0.76 *
15	2.22	0.10	0.98	0.39	0.24	−0.56	0.47	0.87 *
16	0.80	0.10	0.96	1.15	0.24	0.98	0.47	0.78 *
17	1.86	0.12	1.21	0.30	0.24	−0.71	0.47	0.90 *
18	1.13	0.10	0.98	0.83	0.24	0.60	0.47	0.85 *
19	1.23	0.12	1.17	0.76	0.24	−0.16	0.47	0.86 *
20	1.40	0.14	1.38	0.76	0.24	−0.69	0.47	0.83 *
21	1.23	0.13	1.29	0.93	0.24	−0.20	0.47	0.82 *
22	0.92	0.12	1.19	1.19	0.24	0.52	0.47	0.76 *
23	0.88	0.13	1.35	1.37	0.24	0.55	0.47	0.68 *
24	1.35	0.15	1.52	0.69	0.24	−1.02	0.47	0.79 *
25	1.31	0.13	1.33	0.90	0.24	−0.29	0.47	0.82 *
26	2.33	0.09	0.88	0.43	0.24	−0.03	0.47	0.84 *

M = mean; SE = standard error; SD = standard deviation; Sk = skewness; SE = standard error of skewness; K = kurtosis; SK = standard error of kurtosis; SW = Shapiro–Wilk test; Shapiro–Wilk p-value ≤ 0.001 *.

3.4. Eighteen-Item HFS-P—CFA and Reliability

Thus, based on the overall fit indices, factor loadings, and the incorporation of error covariances, a revised two-factor structure using 18 items was proposed for the Portuguese HFS-P (see Figure 1). This model showed a good fit to the data: χ^2 [129] = 220.47; $p \leq 0.001$; $\chi^2/DF = 1.71$; RMSEA = 0.08; SRMR = 0.07; CFI = 0.93; TLI = 0.91; GFI = 0.93. Moreover, Cronbach's alpha results suggest excellent internal consistency for the total scale ($\alpha = 0.93$) and worry subscale ($\alpha = 0.94$), and good internal consistency for the behavior subscale ($\alpha = 0.81$). Similarly, based on McDonald's omega, the total scale ($\omega = 0.93$) and worry subscale ($\omega = 0.94$) demonstrated excellent internal consistency, and the behavior subscale exhibited good internal consistency ($\omega = 0.82$).

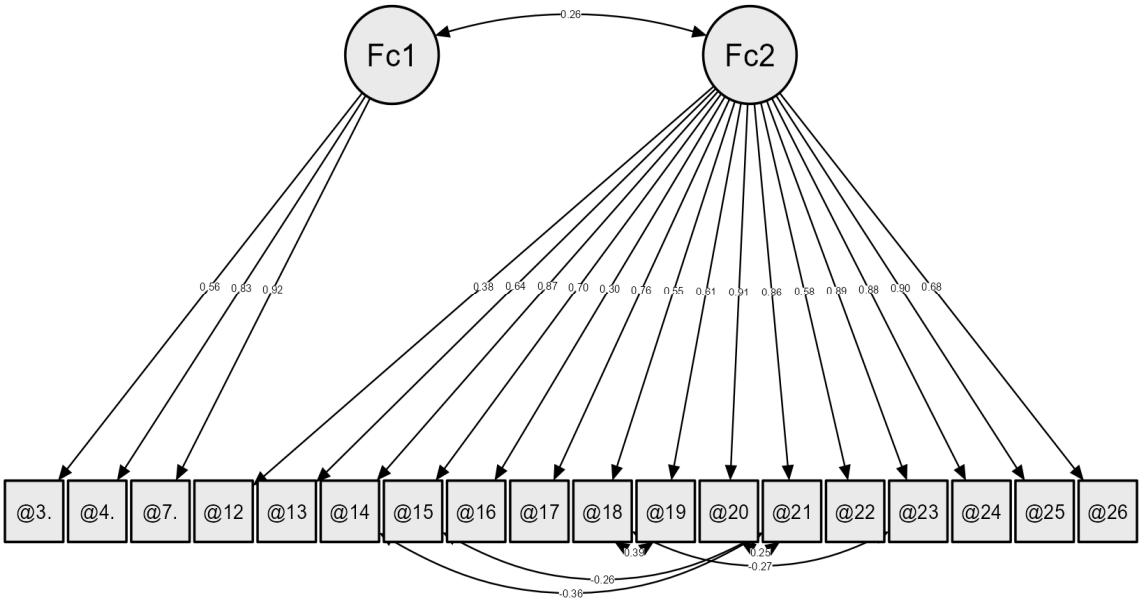

Figure 1. CFA diagram of HFS-P. Two factors, Fc1 = behavior factor, and Fc2 = worry factor.

3.5. Convergent Validity Assessment

To assess convergent validity, Spearman's correlations were computed for both the total and subscale scores of the 18-item Portuguese HFS-P. As shown in Table 3, the parents' HFS-P total score is very strongly associated with their HFS-P worry score and moderately related to their HFS-P behavior score. The parents' HFS-P worry and behavior scores demonstrate a weak positive relationship. Also, the parents' HFS-P total, behavior, and worry scores show weak and statistically significant positive associations with their report of depression and moderate and significant positive associations with their report of anxiety. In contrast, the parents' HFS-P total and worry scores evidence only weak and significant positive associations with their report of diabetes distress. There were no associations observed for the parents' HFS-P scores and their report of stress.

Table 3. Relationships between 18-item HFS-P, DASS-21, and 14-item PAID-PR.

Variables	1. HFS-P Total	2. HFS-P Behavior	3. HFS-P Worry
1. HFS-P Total	—	0.46 ***	0.98 ***
2. HFS-P Behavior	0.46 ***	—	0.28 **
3. HFS-P Worry	0.98 ***	0.28 **	—
4. Depression (DASS-21)	0.29 **	0.20 *	0.27 **
5. Anxiety (DASS-21)	0.32 ***	0.11	0.32 ***
6. Stress (DASS-21)	−0.01	−0.92	−0.01
7. PAID-PR Total	0.23 *	0.14	0.24 *

*** p-value ≤ 0.001, ** p-value ≤ 0.01, and * p-value ≤ 0.05.

4. Discussion

This investigation reflects the first efforts to examine and validate the psychometric properties of the HFS-P [28] among Portuguese parents of children and adolescents living with T1D. It is notable to mention that prior validations of the HFS-P have been conducted in Italy, Norway, Greece, and the United States (see Appendix A for an overview of previous studies on the HFS-P versions). These studies have reported model fit indices and psychometric properties ranging from poor to good [24,28,31–34]. The current validation

study for the Portuguese context used the 26-item HFS-P, which was also the HFS-P version used in the previous Italian and Greek studies [33,34]. Our convenience sample included parents of youths aged 8 to 17 years, which was very similar to the age ranges adopted by the previous American (i.e., 6–18 and 10–17 years old), Italian (i.e., 6–18 years old), and Norwegian (i.e., 6–15 years old) investigations [24,31–34]. Moreover, our sample size (n = 102 parents) is comparable to the sample size used for the Greek validation study (n = 100), and more than twice the size of the sample used in the original American study (n = 46) [28,33]. That said, other validation studies have employed larger samples [24,31,32,34], and it is possible with a larger sample size to attain greater precision and a reduced risk of overfitting, which is an important consideration.

In line with previous findings [28,32], the present study presents a two-factor structure for the Portuguese HFS-P. Several studies using HFS-P and HFS-II have found alternative factor structures, including the three-factor model [24,33,50] (i.e., Maintain High Blood Glucose, Helplessness/Worry About Low Blood Glucose, and Worry About Negative Social Consequences) and a four-factor model [31] (i.e., Maintain High Blood Glucose, Helplessness/Worry About Low Blood Glucose, Worry About Negative Social Consequences, and Avoid/Prevent Low Blood Glucose). Unfortunately, the CFA using all 26 items of the Portuguese HFS-P revealed a poor model fit (i.e., SRMR = 0.09; CFI = 0.85; TLI = 0.83). Though the internal consistency of items ranged from moderate (behavior subscale: ω = 0.68 and α = 0.70) to excellent (total: α = 0.90 and ω = 0.90; worry subscale: α = 0.94 and ω = 0.95) in line with previous studies [32,34], factor loadings and error correlation adjustments suggested the removal of eight items—item 1: "*Have my child eat large snacks at bedtime*"; item 2: "*Avoid having my child being alone when his/her sugar is likely to be low*"; item 5: "*Have my child eat something as soon as he/she feels the first sign of low blood sugar*"; item 6: "*Reduce my child's insulin when I think his/her sugar is too low*"; item 8: "*Have my child carry fast-acting sugar*"; item 9: "*Have my child avoid a lot of exercise when I think his/her sugar is low*"; item 10: "*Check my child's sugar often when he/she plans to go on an outing*"; and item 11: "*Get up in the middle of the night to check on my child or check my child's blood sugar levels*"—which mirrors the results from prior studies [32,33]. It is expected that the removal of these items may be necessary because they are outdated and no longer adequately reflect T1D management now that many youths have access to insulin pumps and continuous glucose monitoring [24]. For example, item 6 may not be relevant now because some insulin pumps have algorithms to automatically adjust insulin delivery and/or to suspend insulin delivery when a low glucose level is detected, thereby reducing a parent's involvement in the routine management of children's glucose levels [32]. It is also possible these items evidenced low factor loadings because many parents were less involved in their child's T1D management, having already transitioned the daily behaviors necessary to manage glucose levels to their child, or because youths were on average more than 5 years out from their T1D diagnosis and parents had the time to learn coping skills to reduce their FH and potential over a reliance on hypoglycemia avoidance behaviors [24]. Finally, it is possible parents' responses to these items were attenuated because of our eligibility criteria. Studies suggest that parents' experience of FH may vary based on a child's age, with parents of very young children reporting increased hypoglycemia avoidance behaviors compared to parents of older youths [27,32,34]. Therefore, it is possible these items may have been more relevant and performed better in our Portuguese HFS-P if we had included parents of very young children living with T1D.

Following item reduction, our 18-item Portuguese HFS-P yielded a good fit to the data (i.e., SRMR = 0.07; CFI = 0.93; TLI = 0.91). This outcome is consistent with the findings from a recent study translating and culturally adapting the HFS-P for the Greek context [33]. However, unlike the findings from the Greek investigation, we found a two-factor structure

(behavior factor: items 3, 4, and 7; and worry factor: items 12–26) provided the best fit for our data, while the Greek study found a three-factor structure best fit their data (behavior factor: items, 3, 4, and 7; and two worry factors: Helplessness/Worry About Low Blood Glucose, items 12–15, 17, 20–21, and 23–26, and Worry About Negative Social Consequences, items 16, 18, 19, and 22) [24,31,33]. After item reduction, our Portuguese HFS-P demonstrated good (behavior subscale: $\alpha = 0.81$) to excellent (total: $\alpha = 0.93$ and worry: $\alpha = 0.94$) internal consistency based on Cronbach's α. These findings are similar to the values reported for the worry subscale (i.e., $\alpha = 0.94$) in an Italian study and the behavior subscale in Greek ($\alpha = 0.85$) and American studies ($\alpha = 0.83$) [24,33,34]. In our study, McDonald's omega further supported the robustness of the 18-item Portuguese HFS-P compared to the 26-item version (total: $\omega = 0.93$, worry: $\omega = 0.94$, and behavior: $\omega = 0.82$).

Finally, when examining the convergent validity of the 18-item Portuguese HFS-P, the weak correlation we observed between the worry and behavior subscales was consistent with the results from another study [32]. Furthermore, as reported in previous research [15,31,32], the significant and positive associations between parents' HFS-P total score and their report of depression and anxiety suggest good convergent validity. Likewise, our findings showing significant and positive associations between parents' FH scores and their report of diabetes distress are consistent with previous research [22,51,52] and suggest good convergent validity.

Limitations, Future Research, Strengths, and Implications for Practice

While our sample size achieved the minimum recommended subject-to-variable ratio (3:1) for the CFA [53], in comparison to other translation studies [24,31], it was relatively small and it was a convenience sample, which may limit the generalizability of our results. Due to our relatively small sample size and a high rate of missing data, it was not possible to conduct stratified analysis by treatment modality and/or youths' HbA1c level, which limits the interpretation of our results. In our sample, only 7.8% of participants were male parents, which represents a limitation and suggests our results may be most representative of mothers' perceptions of FH. In addition, data collection was exclusively conducted online, which may have introduced sampling biases. Finally, the absence of test–retest data also represents a methodological limitation

In the future, researchers should consider using multiple methods to recruit participants (i.e., online and in person) to mitigate possible sampling bias. Future studies should strive to recruit a larger and more diverse sample of parents, including a larger number of male parents, to further evaluate the psychometric robustness of our Portuguese HFS-P. In addition, future studies should attempt to refine our Portuguese HFS-P to include items incorporating the newest technological developments in T1D management (e.g., automated insulin delivery systems) to better capture parents' perceptions of FH and to formulate new hypotheses regarding the challenges parents face when managing their child's T1D. Nevertheless, this investigation makes a significant contribution to the literature by providing new psychometric data for a Portuguese translation of the HFS-P. Our proposed 18-item Portuguese HFS-P appears valid for the assessment and monitoring of parental FH in pediatric diabetes care across Portugal. It is possible healthcare professionals in Portugal could use this measure in an early screening program for parental FH, thereby potentially having a significant impact on both parents' quality of life and their child's T1D management. Furthermore, it is possible psychological interventions (i.e., REDCHIP), delivered by psychologists and tailored to address parental FH in the Portuguese context, may help parents to reduce their FH, enhance their T1D management, and ultimately help them to improve child's glycemic outcomes [25].

5. Conclusions

In summary, the present study adds to an emerging area, namely the validation of the HFS-P in European contexts, where only three previous studies (i.e., Greece, Norway, and Italy) have been conducted. Our aim was to translate and validate the 26-item HFS-P for the Portuguese context. Our findings support the use of a shortened 18-item and two-factor version of the HFS-P, which evidenced good internal consistency and good convergent validity in our sample of Portuguese parents of youths living with T1D. Future investigations should expand upon our results with larger and more diverse samples. It is also necessary to consider refining items of our Portuguese HFS-P to reflect modern T1D management and the use of technology. However, presently, our Portuguese HFS-P may serve as a helpful tool for healthcare professionals aiming to screen parents for FH and to provide them with timely psychological interventions targeting their FH, which could potentially also enhance parents' T1D management and help to reduce children's glycemic levels.

Author Contributions: Conceptualization: V.C. and T.B.; Methodology: V.C.; Formal analysis: V.C.; Writing—Original Draft: V.C.; Writing—Review and Editing: all authors; Supervision: S.R.P., S.d.V. and T.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by a Portuguese doctoral scholarship (No. 2024.00467.BDANA), awarded to Vasco Vicente Costa by the Foundation for Science and Technology.

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of ISPA–University Institute (Reference: D-080-4-24 and approved on 12 March 2024).

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

Data Availability Statement: The data from this study may be obtained by contacting the corresponding author.

Acknowledgments: The authors greatly appreciate the cooperation of Pedro Ribeiro, and Bárbara Pereira for their help on the translation procedure of this instrument.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

T1D	Type 1 Diabetes
FH	Fear of Hypoglycemia
HFS-P	Hypoglycemia Fear Survey—Parents
HFS	Hypoglycemia Fear Survey
REDCHIP	Reducing Emotional Distress For Childhood Hypoglycemia in Parents
PAID-PR	Problem Areas in Diabetes Survey—Parent Revised
DASS-21	Depression Anxiety Stress Scales
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
TLI	Tucker–Lewis Index
SRMSR	Standardized Root Mean Square Residual
GFI	Goodness of Fit Index
χ^2/DF	Chi-Square Divided by Degrees of Freedom
RMSEA	Root Men Square Error of Approximation
M	Mean
SE	Standard Error

SD	Standard Deviation
SE	Standard Error of Skewness
K	Kurtosis
SK	Standard Error of Kurtosis
SW	Shapiro–Wilk
HFS-P-NF	Hypoglycemia Fear Survey—Parent, Nighttime Fear
HFS-P-YC	Hypoglycemia Fear Survey—Parents of Young Children
HFS-C	Hypoglycemia Fear Survey—Child Version

Appendix A HFS-P Versions Overview

Country	Authors and Year	HFS-P Structure, Items, and Final Version
Greece	Kostopoulou et al. [33]	• Baseline 26-item version (Behavior Factor: Items 1–11 and Worry Factor: Items 12–26). • 18-item three-factor final structure (Behavior Factor: *Maintaining High Blood Glucose*: Items 3, 4, and 7; Worry Factors: *Helplessness/Worry About Low Blood Glucose*: Items 12, 13, 14, 15, 17, 20, 21, 23, 24, 25, and 26, and *Worry About Negative Social Consequences:* Items 16, 18, 19, and 22).
Italy	Tumini et al. [34]	• Baseline 26-item version (Behavior: Items 1–11 and Worry factor: Items 12–26). • 25-item final version (Behavior Factor: Items 2–11 and Worry Factor: Items 12–26).
Norway	Haugstvedt et al. [32]	• Baseline and 25-item final version (Behavior Factor: Items 1–10 and Worry Factor: Items 11–25).
Portugal	Costa et al. [36]	• Baseline 26-item version (Behavior Factor: Items 1–11 and Worry Factor: Items 12–26). • 18-item two-factor final structure (Behavior Factor: Items 3, 4, and 7, and Worry Factor: Items 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, and 26).
United States (original study)	Clarke et al. [28]	• Baseline 25-item and final version (Behavior Factor: Items 1–10 and Worry Factor: Items 11–25).
United States	O'Donnell et al. [24]	• Baseline 25-item version (Behavior Factor: *Maintain High Blood Glucose* Worry Factors: *Helplessness/Worry About Low Blood Glucose* and *Worry About Negative Social Consequences*). • 19-item three-factor final structure (Behavior Factor: *Maintain High Blood Glucose*: Items 3, 4, and 7; Worry Factors: *Helplessness/Worry About Low Blood Glucose*: Items 2, 11, 12, 13, 14, 15, 17, 19, 20, 23, 24, and 25, and *Worry About Negative Social Consequences:* Items 16, 18, 21, and 22).
United States	Shepard et al. [31]	• Baseline 25-item version (Behavior Factor: Items 1–10 and Worry Factor: Items 11–25). • 22-item four-factor final structure (Behavior Factors: *Maintain High Blood Glucose*: Items 1, 3, 4, and 7; *Avoid/Prevent Low Blood Glucose:* Items 2, 5, 6, 8, 9, and 10; Worry Factors: *Helplessness/Worry About Low Blood Glucose:* Items 12, 13, 14, 15, 17, 20, 23, 24, and 25; *and Worry About Negative Social Consequences:* Items 16, 21, and 22).

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