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TITLE Adaptation and Validation of the Self-Administered Foot Health Assessment Instrument for Portuguese Undergraduate Nursing Students

YEAR 2024

DOI 10.1891/jnm-2023-0095

CITATION Bernardes, R. A., Caldeira, S., Stolt, M., Paiva-Santos, F., Santos-Costa, P., & Cruz, A. G. (2024). Adaptation and Validation of the Self-Administered Foot Health Assessment Instrument for Portuguese Undergraduate Nursing Students. *Journal of Nursing Measurement*, JNM-2023-0095.R1. https://doi.org/10.1891/jnm-2023-0095

VERSION Accepted Manuscript

Adaptation and Validation of the Self-Administered Foot Health Assessment Instrument (S-FHAI) for Portuguese Undergraduate Nursing Students

Short Running Title: Validation of S-FHAI for Portuguese Nursing Students

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Abstract. Aims. To translate and adapt the S-FHAI from English into European Portuguese and explore its reliability and validity among undergraduate nursing students in Portugal. Design. Cross-sectional methodological study. Methods. The study was divided into two phases. First, the translation and cross-cultural adaptation which followed Beaton's guidelines, with a pretesting of the final version with 30 students. The validation process used the content validity index with a minimum of 75% of agreement between experts and Cronbach's alpha for internal consistency. The second step provided the results of the Principal Component Analysis and Confirmatory Factor Analysis, which were performed to study the overall fit of the model and item correlations. Results. The Portuguese version (IAASP) showed an overall acceptable evidence regarding content validity and internal consistency. The results of the factor analysis suggested the removal of the 'Foot pain' dimension from the original scale. Conclusions. IAASP is suggested to maintain the original 22-item structure, with four domains 'Foot health', 'Nail health', 'Foot structure' and 'Foot pain', being an initial reliable version with interest to measure the current foot health of nursing students. Future studies should contribute to IAASP continuous improvement. Relevance to clinical practice. Improving the nursing students' foot health and capacity to self-evaluation will contribute to a better quality of life during their academic progress.

Keywords: foot health, nursing students, psychometric properties, research in practice, translation

Introduction

Foot and ankle disorders among nursing professionals are common work-related musculoskeletal disorders (WRMSD; Abledu & Offei, 2015; Oliveira et al., 2017). However, studies reporting this condition on nurses and students are scarce (Stolt et al., 2017). The prevalence of WRMSDs among nursing students can be as high as 83% (Moodley et al., 2020), with reports of worsening health

since starting nursing school (Martin et al., 2022). Moreover, the physical demands during nursing education are an important factor associated with students' late dropout (Bakker et al., 2019). Likewise, foot and ankle disorders contributed to an intention to leave rate of 39% among nursing students and an actual dropout rate of 3.4% (Kox et al. ,2022)

Exposure to standing environments is one of the most prominent risk factors for developing these disorders. According to a recent study, constant exposure to prolonged standing has a 1.7-fold increase in the risk of foot pain (Anderson et al., 2017), one of this population's most complex and frequent disorders (Bernardes et al., 2023). Recent studies reported that nursing students walk more than 30 hours weekly in the clinical environment (Cilar et al., 2016), thus increasing the risk of rapid depletion of foot and ankle health.

In this sense, prevention and self-assessment practices are priority areas to increase nursing students' occupational health and quality of life (Ou et al., 2021). Moreover, gaining knowledge about nursing students' resilience, sense of wellness, and well-being is essential for developing tailored educational initiatives for disease prevention (Spurr et al., 2021).

Furthermore, self-reported health is related to well-being in nursing students and may help develop targeted interventions within nursing educational programs (Martin et al., 2022). Nevertheless, currently, there is a lack of self-reported instruments to assess foot health explicitly targeting undergraduate nursing students in Portugal.

Background

The Self-Administered Foot Health Assessment Instrument (S-FHAI) was developed in Finland by Stolt and colleagues (2017). Following its early development, S-FHAI had subsequent exploratory studies of its characteristics throughout the years (Stolt et al., 2012, 2017, 2023), with mild changes occurring in its structure. The S-FHAI was developed in Finnish and later translated using a standard forward-back translation procedure to English.

S-FHAI is a self-reported instrument that measures a person's current level of foot health, being structured into 22 items divided into four dimensions: skin health (11 items), nail health (4 items), foot structure (5 items), and foot pain (2 items). All items are dichotomous ('yes' or 'no' response), except for item 22, which is a Likert-type scale ranging from '1' (No pain) to '5' (Worst imaginable pain). The output of S-FHAI is the Foot Health Index, ranging from 0 to 46, with higher scores meaning worst foot health. This instrument is based on the Foot Health Assessment Instrument (FHAI; Stolt et al., 2013), initially developed for nurses to assess foot health in older people.

The S-FHAI has been used recently to evaluate the prevalence of foot health in older people with rheumatoid arthritis (Stolt et al., 2020), foot health problems in people living with other rheumatoid conditions (Stolt et al., 2023), and foot health of nurses (Stolt et al., 2017).

While the original FHAI (Stolt et al., 2013) has shown reasonable internal consistency values (α = 0.64), the S-FHAI versions used with people with rheumatoid conditions and nurses showed a slight improvement, with medium Cronbach's alpha values, 0.720 and 0.721, respectively. Moreover, Rasch analysis showed that the S-FHAI is a unidimensional scale with acceptable item fit. High item separation demonstrated clear discrimination between the items. Person fit and person separation

were identified as low, meaning restricted separation among different respondents (Stolt et al. 2021).

This study aimed to translate and adapt the S-FHAI from English into European Portuguese and explore its reliability and validity among undergraduate nursing students in Portugal.

Methods

Design

This is a cross-sectional methodological study (Polit & Beck 2008), with two main steps: (1) translation and cross-cultural adaptation for European Portuguese; and (2) psychometric analysis of the instrument's characteristics.

Translation and Cross-Cultural Adaptation

The process followed the guidelines proposed by Beaton and colleagues (2000) and was developed in a five-staged process (Table 1).

Table 1. *Process for the Translation and Cross-Cultural Adaptation*

Stage	Description	Deliverable
Translation	Three independent translators with no previous knowledge of the instrument. Two nurses and one mechanical engineer were recruited with English proficiency and whose mother tongue was Portuguese. Each translator received the original instrument and a report sheet to provide comments and suggestions.	Written report for each version (T1, T2 & T3)
Synthesis	Translation 1 (T1), Translation 2 (T2), and Translation 3 (T3) were merged into T-12. A meeting with the research team and the original author resolved conflicts between the translator's suggestions.	Written Report for T-12
Back Translation	Two professional translators who had no previous knowledge or expertise in the topic were recruited. Two back translations (BT) were created from T-12: BT1 and BT2	Written report for each version (BT1 & BT2)
Expert Committee Review	An expert committee composed of seven experts –nurses who worked in the diabetic foot or foot health – were recruited to evaluate the documents produced by the previous stages and reach a pre-final version. All experts received the original instrument, the translations to Portuguese (T1 & T2), the synthesis and (T-12), and the two back translations (BT1 & BT2).	Written report for the prefinal version
Pretesting	A total of 30 nursing students were recruited to complete the translated version of S-FHAI and describe their understanding of each item.	Written report

S-FHAI: Self-Administered Foot Health Assessment Instrument; T1: Translation 1; T2: Translation 2; T3: Translation 3; T-12: Synthesis of T1, T2 and T3; BT1: Back-translation 1; BT2: Back-translation2

Validation and Psychometric Properties of the Scale

Firstly, content validity was assessed through an expert panel of nurses with experience in foot health and podiatrists, mainly through the content validity index (I-CVI). A consensus method was developed, with several rounds until agreement was achieved between experts. Items with a mean score of 0.75 or higher were retained. Those who failed to achieve consensus were exposed to a new round. Cronbach's alpha was used for internal consistency, considering the following values (Marôco, 2021): > 0.9 very good; 0.8 – 0.9 good; 0.7 – 0.8 medium; 0.6 – 0.7 reasonable; 0.5 – 0.6 bad; < 0.5 unacceptable. Item-to-total correlations were also determined, considering a minimum recommended correlation between items and total scores above 0.20 (Streiner & Norman, 2003).

Principal Component Analysis (PCA) with Varimax rotation and Confirmatory Factor Analysis (CFA) with maximum-likelihood estimation was used to assess construct validity. Data adequacy for structural equation modelling (SEM) was performed through Kaiser-Meyer-Olkin (KMO) test. Values of 0.5 or above and Bartlett's test of sphericity with a *p*-value below 0.05 were considered (Child, 2006).

The *rationale* for the retention of factor loading in PCA was supported by three assumptions: eigenvalues greater than 1, the inflexion point in the scree plot, and a minimum of 50% of total variance explained or factors extracting at least 5% of the total variance (Watson & Thompson, 2006; Marôco, 2021). Additionally, commonalities (h^2) were used to describe the variance in a single variable, with item loadings above 0.30 on a component considered acceptable (Child, 2006).

Regarding the CFA, a non-significant chi-square (X^2) was considered acceptable (Child, 2006). Additional tests were completed to study data fit the proposed model: the comparative fit index (CFI), with values above 0.95 meaning an excellent fit (West et al., 2012); the root mean square error of approximation (RMSEA), where values below 0.05 indicate an excellent fit and between 0.05 and 0.08 a moderate fit (MacCallum et al., 29916; Musil et al., 1998); the goodness of fit index (GFI), where a value of 1 represents a perfect fit, 0.9 or higher a reasonable fit (Hu & Bentler, 1998) and above 0.95 an excellent fit (Kline, 2005).

The sample size was guided by the recommendations of Boateng and colleagues (2018), namely having 10 respondents per survey item or 200-300 observations. Criteria for selecting nursing students were being enrolled in a Portuguese nursing school at the moment of recruitment, being in clinical learning environments at the moment of the recruitment or in the previous two weeks and having no previous knowledge about the instrument. Recruitment was performed via e-mail and sent to the coordinators of each academic year, where the project summary and criteria were disclosed. The responses were collected online via *Qualtrics XM*

Data were analyzed using SPSS v.26 and SPSS AMOS v.26 (IBM, New York, USA).

Ethical Considerations

To reach an adequate sample of nursing students, the coordinators of nursing bachelors across Portugal were presented with the project, objectives, and criteria for inclusion. The e-mail was sent with a brief description of the study, with an anonymous link to the questionnaire, including informed consent. According to the described criteria, the coordinators were asked to forward freely to cohorts of students they considered adequate for the study.

Inside the questionnaire page, students had to read the page with a detailed description of the project, disclosing that it was part of a doctoral research project, with a voluntary nature, anonymous, and with no benefits or harm to their current or future academic work. The contacts of the main contact person (principal investigator) were given for any questions or if clarifications were needed.

The Ethical Committee of the Health Sciences Research Unit: Nursing (UICISA: E) of the Nursing School of Coimbra (ESEnfC) approved the study (P799_07_2021).

Results

Translation and Cross-Cultural Adaptation of S-FHAI

Two rounds were needed to acquire more than 75% (I-CVI) of the agreement between experts in all items. The Portuguese version of S-FHAI (Table 2) was named *Instrumento de Auto-Avaliação da Saúde do Pé (IAASP)*.

The "problematic" items were *Item 9 – Burning Feet* and *Item 13 – Thickened Toenails*. Experts agreed to add an explanatory note to *Item 9*, characterising the burning sensation on the feet, and discussed a synonym to the English word of *Item 13* to increase comprehension in the Portuguese population.

Regarding semantic equivalence, it ranged between 94% to 100%, indicating that the translated version was a correct reflection of the original version (Portney & Watkins, 2009). The pre-test with 30 nursing students revealed no difficulties in comprehending items and meaning.

Table 2. *The Portuguese Translation of S-FHAI*

Translated Version
Instrumento de Auto-Avaliação da Saúde do Pé (IAASP)
O Instrumento de Auto-Avaliação da Saúde do Pé (IAASP) consiste em quatro subcategorias: I) Saúde a Pele, II) Saúde das Unhas, III) Estrutura dos Pés, IV) Dor nos Pés. Avalie a saúde atual do seu pé de acordo com os itens do formulário. Faça um círculo na opção que mais se adequa ao que observou.
Saúde da Pé
1. Gretas na pele ou maceração entre os dedos dos pés
2. Pele seca
3. Fissuras nos calcanhares
4. Calos ou calosidades
5. Verrugas
6. Bolhas
7. Edema
8. Pés suados
9. Pés queimados (sensação de ardor nos pés)
10. Pés frios
11. Cãibras nas pernas
Saúde das Unhas
12. Unhas encravadas
13. Unhas engrossadas
14. Alterações na coloração das unhas
15. Infeção fúngica nas unhas
Estrutura dos Pés
16. *Hallux valgus* (o 1º dedo está visivelmente voltado contra os outros dedos)
17. Joanete de Taylor (o 5º dedo está visivelmente voltado contra os outros dedos)
18. Deformidades menores dos dedos do pé (o dedo ou dedos estão fletidos)
19. Arco do pé baixo (o arco do pé está visivelmente diminuído)
20. Arco do pé alto (o arco do pé está visivelmente elevado)
Dor nos Pés
21. Nas últimas duas semanas, tem tido dores nos pés?
22. Qual a localização e intensidade da sua dor no pé?
22.1 Dedos
22.2 Planta do Pé

22.3 Calcanhar
22.4 Tornozelo
22.5 Joelho
22.6 Coxa
22.7 Anca

Internal Consistency

A total of 297 undergraduate nursing students received the questionnaire, but only 208 completely answered the items needed for validation (Table 3; response rate of 70.03%).

Table 3. *Characterisation of the sample (n=208)*

		n (%)	M(SD)
Sex	Male	14 (6,7)	
	Female	90 (43,3)	
		104 (100)	
	Missing	104	
	Total	208	
Daily Average Time Standing in Clinical Environment	< 3 h	24 (11,5)	
	3h	10 (4,8)	
	> 3h	70 (33,7)	
		104 (100)	
	Missing	104	
	Total	208	
Daily Average Time Walking in Clinical Environment	< 3h	12 (5,8)	
	3h	12 (5,8)	
	> 3h	80 (38,5)	
		104 (100)	
	Missing	104	
	Total	208	
Do you know your Nursing School's recommendations for adequate footwear?	Yes	86 (41,3)	
	No	18 (8,7)	
		104 (100)	
	Missing	104	
	Total	208	
Age			23,03 (4,98)
Weight			64,64 (13,491)
Height			165,46 (6,488)

M: mean; SD: standard deviation

Following previous studies with S-FHAI (Stolt et al., 2023), we didn't consider item 22 for the internal consistency since it is the only Likert-type answer compared to the remaining dichotomous scale. While the instrument's global Cronbach's Alpha was 0.593, after removing item 21, it satisfactorily increased to 0.653. The subscales "Skin Health", "Nail Health," and "Foot Structure" had internal consistency values of 0.502, 0.504, and 0.483, respectively.

Principal Component Analysis (PCA)

Data adequacy to perform SEM was found to be mediocre (KMO = 0.601; X^2 = 0.000; Table 4).

Table 4. *KMO and Bartlett's Test of Sphericity for SEM Adequacy*

KMO Measure	0.601	
Bartlett's Test of Sphericity	Aprox. X^2	481.897
	gl	190
	Sig.	0.000

KMO: Kaiser-Meyer-Olkin; SEM: Structural Equation Modelling; X^2: Chi-Square

PCA with Varimax rotation revealed nine components (C) with an eigenvalue above 1 (range 1.024 – 2.907). After thoroughly analysing all loadings and extracted components, three components were considered for the scale validation (Table 5), with a total explained variance of 30.05% . This decision is supported by the inflection point in the scree plot found in C3 and the factor loadings between components.

Regarding homogeneity, item-to-total correlations were determined and assessed. Item 5 had a weak correlation (<0.2), but its removal didn't affect internal consistency, thus advocating for its maintenance in the scale. The same *rationale* was applied for items 4, 6, and 13, which had h^2 values lower than 0.5, but did not influence the global or subscale internal consistency.

Table 5. *Item and scale description, item-to-total correlations, Cronbach's alpha values, and principal component analysis with Varimax rotation*

Abbreviated Item	Item-to-Total Correlation	Cronbach's Alpha	h^2	S-FHAI			
Skin Health		0,502		C1	C3	C2	C6
Skin breaks or maceration between toes	0.427		0.612	0.292	0.048	-0.180	0.443
Dry skin	0.487		0.565	0.102	-0.072	0.084	0.138
Fissures in the heel	0.269		0.790	-0.066	0.059	-0.028	0.878
Corns or calluses	0.366		0.490	-0.036	-0.213	0.367	0.269
Verrucae	0.191		0.574	0.076	-0.179	-0.046	0.156
Blisters	0.287		0.461	-0.168	0.202	0.104	-0.009
Oedema	0.435		0.629	0.027	0.652	0.054	0.151
Sweating feet	0.373		0.736	-0.030	0.172	0.025	-0.073
Burning feet	0.347		0.681	0.189	0.760	0.050	0.009
Cold feet	0.328		0.736	0.023	0.145	0.147	0.008
Leg cramps	0.293		0.700	0.036	0.000	0.116	0.030
Nail Health		0,504					
Ingrown toenail	0.363		0.710	0.035	0.148	0.068	-0.081
Thickened nail	0.283		0.484	0.423	-0.226	0.331	-0.025
Colour changes in the nails	0.523		0.713	0.798	0.148	0.149	0.015
Fungal infection of the nails	0.424		0.742	0.843	0.094	0.125	-0.025
Foot Structure		0,483					
Hallux valgus	0.451		0.568	0.183	0.085	0.692	0.081
Taylor's bunion	0.424		0.595	0.163	-0.001	0.685	-0.176
Hammer toe	0.335		0.624	0.043	0.172	0.515	0.048
Low foot arch	0.274		0.708	0.081	0.133	0.060	0.027
High foot arch	0.420		0.635	0.045	0.336	0.392	0.455
Global Scale		0.653					

h^2: communalities

Confirmatory Factor Analysis (CFA)

We developed a CFA to confirm data fit the initial four-dimensional S-FHAI structure (Figure 1A), thus including items 21 and 22 ("Foot Pain"), after which an improved model was acquired (Figure 1B), removing the variables related to the "Foot Pain" dimension, thus confirming the hypothesized three-component structured. The adjusted model revealed adequate chi-square values and goodness-of-fit index (Table 6).

Table 6. *Testing (CFA) of the hypothesized structure of the SFHAI (n=208)*

	Default Model	Foot Pain Model 1	Adjusted Model	Skin Model 1	Nails Model 1	Foot Structure Model 1
GFI	-	-	0,913	0,956	1,000	0,982
CMIN/DF	1.428	2.408	1,308	1,275	0,098	1,856
CFI	0.696	0.717	0,833	0,848	1,000	0,922

RMSEA	0.045	0.082	0,039	0,036	0,000	0,064

GFI: goodness-of-fit index; CMIN/DF: chi-square; CFI: comparative fit index; RMSEA: root mean square error of approximation

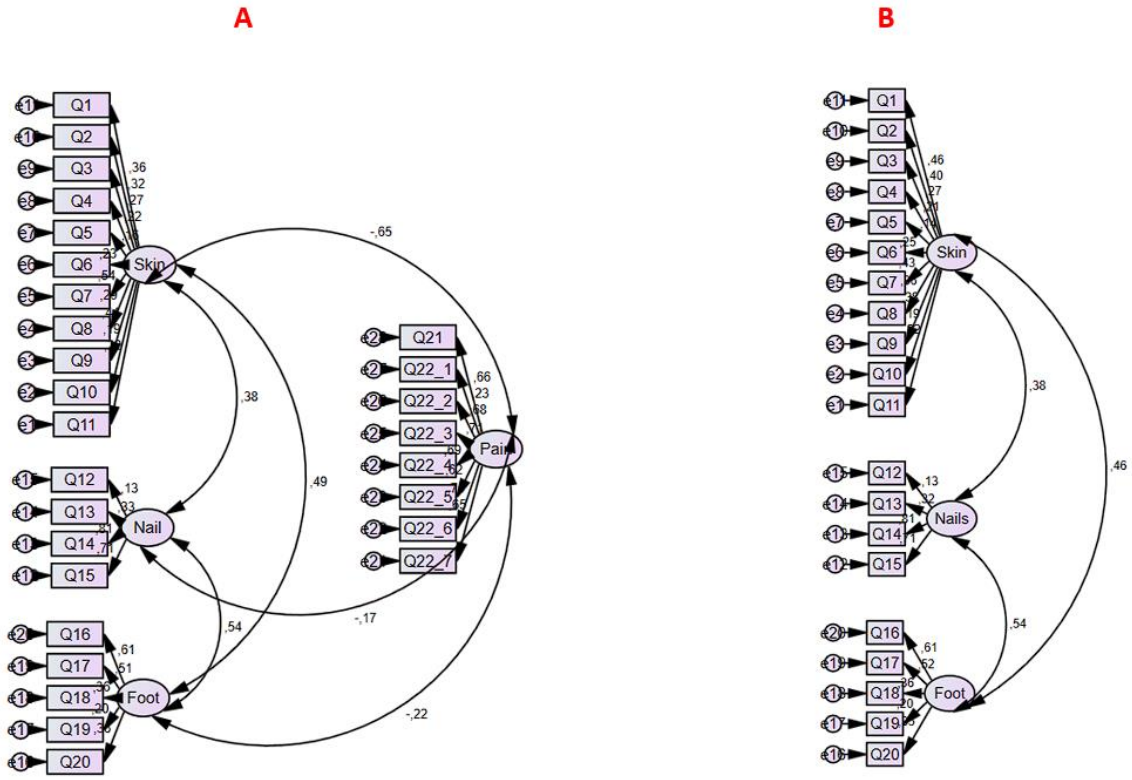

Figure 1. *Structure of Theoretical Model of IAASP* (A: Default Model; B: Adjusted Model)

Discussion

This study described the translation and validation process of IAASP, the Portuguese version of the Self-Administered Foot Health Assessment Instrument (S-FHAI), and evidenced its satisfactory psychometric properties.

Translation and Adaptation of S-FHAI

The original instrument has easy-to-understand items, often names of signs or symptoms usually of "common sense". This characteristic makes it a very simple instrument, and the results of this study indicate that IASSP is linguistically and culturally adequate and relevant to undergraduate nursing students.

Despite the previous fact, some items were identified as "problematic". Following the expert's comments and suggestions, a discussion around item 9 led to a different wording in the final version of the instrument. The importance of "foot health" isn't typical among nursing students, as the most often reported regions are the lower back, neck, and knees (Antochevis-de-Oliveira et al., 2017). While most items are easily comprehended, "burning feet" would generate doubts. In this sense, experts agreed to add an explanation of how nursing students can experience the sensation of a burning foot. Variations in students' knowledge and how advanced they are in the nursing degree

can also influence the comprehension of more complex symptoms. Moreover, in the Portuguese language, homonymy and synonymy are very common, thus a need to carefully review the words. Regarding item 13 ("Thickened toenail"), the experts suggested a change in the words equally provided during the translation and back-translation to a more usually used concept, maintaining the original meaning.

Psychometric Analysis

The psychometric analysis of the items of IAASP has revealed a three-dimensional structure (Skin Health, Nail Health, and Foot Structure) with satisfactory properties.

Regarding the instrument's internal consistency, we have acquired similar values ($\alpha = 0.65$) as the original scale ($\alpha = 0.64$) but slightly inferior values than the S-FHAI adaptation, mainly when applied to nurses ($\alpha = 0.72$).

The individual subscales' internal consistent values were like the original scale. In the original development study of FHAI, Stolt and colleagues (2013) obtained values of 0.49, 0.46, and 0.46 in the skin health, nail health, and foot structure subscales, respectively, while we obtained 0.50, 0.50, and 0.48. Also, in the original studies with S-FHAI, Stolt and colleagues (2017) acquired internal consistency values of 0.441, 0.562, and 0.180 in the skin health, nail health, and foot structure subscales, respectively, slightly inferior to our study.

The statistical analysis recommended skipping an essential dimension of foot health, previously named "Foot Pain". Our suggestion for the final IAASP version is to maintain the original fourth dimension, despite the unsatisfactory psychometric findings. A conceptual and a statistical reason can be evoked. The first reason is derived from the conceptualisation of "Foot Health" and previous studies. Our recent review (Bernardes et al., 2023) found the inclusion of pain in every nurse report regarding WRMSDs and that it had many variations. Also, it should be noted that chronic foot pain (CFP) is significantly disabling for nurses (Mbue & Wang, 2023), affecting productivity and quality of life, evidencing the need to systematically assess pain levels and location. Furthermore, in several studies, foot health has been consistently characterized by pain levels in different regions, although highlighting difficulties in its analysis since there are considerable variations in case definitions ((Stolt et al., 2020; Gates et al., 2019; Rodríguez-Sanz et al., 2018).

The second reason is mainly associated with internal consistency and factor loadings. While consistency estimates how consistently individuals respond to the items within a scale, we now know that Cronbach's alpha usually masks inconsistencies between answers and that inconsistency among responses might be essential to notice (Vaske et al., 2017). If a response pattern is random, the problem might not be severe enough to promote changes in the instrument's structure. In our study, the Foot Pain dimension acquired lower consistency values than in previous studies (Stolt et al., 2013; Stolt et al., 2016), which might represent the low expertise of nursing students and poor self-assessment ability. Moreover, items that reflect the theoretical core of the construct might not correlate strongly with it in preliminary analyses, like the Foot Pain items. Still, it's not wise to eliminate them without exploring their behaviour (Clark & Watson, 1995) in future studies.

Implications for policy and practice

A valid and reliable self-assessment instrument for nursing students' foot health is essential to show their current status, which disorders are being developed, and what tailored interventions should be developed. This is the first step in adapting and validating IAASP, revealing the need to continue its analysis in further research.

Methodological Considerations and Limitations

Some methodological considerations should be described in relation to the generalisation of the results.

The undergraduate nursing students who answered the questionnaire were mainly from the last two years of their bachelor's degree. Different realities might occur in different countries, and students' experiences and knowledge might influence responses. Nevertheless, the sample was distributed throughout many public and private nursing schools in Portugal, which is a strength. As this was a cross-sectional study, we didn't evaluate test-retest values, which should be performed in the future, and a Rasch analysis to explore the unidimensionality of factors.

Conclusion

Evaluating undergraduate nursing students' current foot health is necessary to promote self-care and high occupational health status. The psychometric properties of IAASP were tested, and the results revealed satisfactory validity, reliability, and internal consistency values. Some of the items of IAASP need further testing to keep improving the instrument for this population.

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