

RESEARCH ARTICLE (ORIGINAL)

Layout for Assessing Dynamic Posture: Translation, Cross-Cultural Adaptation, and Psychometric Validation in Portuguese Preadolescents

Lay-out for Assessing Dynamic Posture: Tradução, Adaptação Cultural e Validação Psicométrica em Pré-Adolescentes Portugueses

Lay-out for Assessing Dynamic Posture: traducción, adaptación cultural y validación psicométrica en preadolescentes portugueses

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Abstract

Background: Questionnaires assessing postural habits and body posture generally do not allow for the evaluation of dynamic postures or the measurement of how postural knowledge is transferred to movement execution. This limitation can be overcome when dynamic posture is captured on film. **Objective:** To translate, culturally adapt, and psychometrically evaluate the Layout for Assessing Dynamic Posture (LADy) for use with Portuguese preadolescents.

Methodology: A methodological study involving translation, cross-cultural adaptation, and psychometric testing was conducted, including an assessment of the inter-rater reproducibility of the instrument.

Results: Fifty-nine preadolescents from a school cluster in northern Portugal participated. Inter-rater reproducibility across items ranged from minimal to excellent ($k=0.04-1$). Of the nine dynamic postures and 53 assessment items in the original LADy, eight postures and 38 items were retained in the Portuguese version.

Conclusion: The LADy-PT is a valid and reproducible instrument for assessing dynamic posture in preadolescents within a school context, provided that its application guidelines are followed.

Keywords: postural balance; child; adolescent; validation study; school health services; rehabilitation nursing

Resumo

Enquadramento: Os questionários de avaliação dos hábitos posturais e da postura corporal, em geral, não são capazes de avaliar as posturas dinâmicas, nem de mensurar a transferência do conhecimento para a execução do movimento, facto este facilmente observado na filmagem da postura dinâmica.

Objetivo: Traduzir, adaptar culturalmente e analisar psicometricamente o esquema de avaliação da postura dinâmica *Lay-out for Assessing Dynamic Posture* (LADy), em pré-adolescentes portugueses.

Metodologia: Foi desenvolvido um estudo metodológico de tradução, adaptação cultural e análise psicométrica, em que foi avaliada a reprodutibilidade inter-avaliadores do instrumento.

Resultados: Participaram no estudo 59 pré-adolescentes, de um agrupamento escolar do norte de Portugal. A reprodutibilidade para cada item foi avaliada de *mínima a excelente* ($k = 0,04$ a 1). Das nove posturas dinâmicas e dos 53 itens de avaliação que constituem o LADy original, foram mantidas oito e, respetivamente, 38 itens, na versão portuguesa.

Conclusão: O LADy-Portugal é um instrumento válido e reprodutível para avaliar a postura dinâmica dos pré-adolescentes em contexto escolar, desde que cumpridas as instruções do seu uso.

Palavras-chave: equilíbrio postural; criança; adolescente; estudo de validação; serviços de saúde escolar; enfermagem em reabilitação

Resumen

Marco contextual: Los cuestionarios de evaluación de los hábitos posturales y de la postura corporal, en general, no son capaces de evaluar las posturas dinámicas ni de medir la transferencia del conocimiento a la ejecución del movimiento, hecho que se observa fácilmente en la grabación de la postura dinámica.

Objetivo: Traducir, adaptar culturalmente y analizar psicométricamente el esquema de evaluación de la postura dinámica *Lay-out for Assessing Dynamic Posture* (LADy), en preadolescentes portugueses.

Metodología: Se desarrolló un estudio metodológico de traducción, adaptación cultural y análisis psicométrico, en el que se evaluó la reproductibilidad interevaluadores del instrumento.

Resultados: En el estudio participaron 59 preadolescentes de un grupo escolar del norte de Portugal. La reproductibilidad de cada ítem se evaluó de *mínima a excelente*.

($k = 0,04$ a 1). De las nueve posturas dinámicas y los 53 ítems de evaluación que constituyen el LADy original, se mantuvieron ocho y, respectivamente, 38 ítems en la versión portuguesa.

Conclusión: El LADy-Portugal es un instrumento válido y reproducible para evaluar la postura dinámica de los preadolescentes en el contexto escolar, siempre que se sigan las instrucciones de uso.

Palabras clave: equilibrio postural; niño; adolescente; estudio de validación; servicios de salud escolar; enfermería en rehabilitación



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Introduction

The Portuguese National School Health Program, currently in force, emphasizes that health promotion in schools should be based on the real needs of the population, developing teaching and learning processes that improve academic results, contribute to raising health literacy levels, and enhance the lifestyle of each school community (CE; Direção-Geral da Saúde, 2015). In line with this, the European Agency for Safety and Health at Work stresses that ongoing and systematic research into musculoskeletal disorders (MSDs) in children and adolescents, using appropriately validated instruments, deserves priority (Schmidt et al., 2021). This will guide the development of interventions to promote musculoskeletal health based on scientific evidence and aimed at prevention (Schmidt et al., 2021). Thus, questionnaires assessing postural habits and body posture in general are not capable of evaluating the dynamic postures of children and adolescents in domestic and/or school contexts. They also do not measure the incorporation of theoretical knowledge into practice, or, in other words, the transfer of knowledge about postural education to movement execution, a fact that is easily observed through the filming of dynamic postures (Noll et al., 2013). On the other hand, filming circuits appear suitable for situations in which there is a need to assess, qualitatively and in greater depth, the different aspects that can affect body posture in motion (Antoniolli et al., 2015). The present study aims to provide a validated dynamic body posture assessment instrument and to contribute to promoting musculoskeletal health in school contexts. To this end, it seeks to translate, cross-culturally adapt, and psychometrically analyze the Layout for Assessing Dynamic Posture (LADy) in Portuguese preadolescents.

Research question

Is the LADy a valid instrument for assessing the dynamic posture of preadolescents in school contexts?

Background

The state of the musculoskeletal system is one of the most important indicators of physical development and health, particularly among children and adolescents (Geng et al., 2023). Painful, inflammatory, and/or degenerative changes affecting the musculoskeletal system are referred to as MSDs (WorkSafe New Zealand, 2022). MSDs are becoming increasingly prevalent in children and adolescents between the ages of 5 and 14, ranking as the 10th leading cause of years lived with disability worldwide and the 4th leading cause in Portugal (8.31%; Institute for Health Metrics and Evaluation, 2021). Low back pain is the leading cause of years lived with disability worldwide and affects people of all ages, including children and adolescents (Institute for Health Metrics and Evaluation, 2021). Many musculoskeletal symptoms result from a combina-

tion of various individual and acquired risk factors, the latter considered potentially preventable (Schmidt et al., 2021). Considering that MSDs in children and adolescents may have multiple causes, it is important to consider the postural habits developed when performing activities of daily living (ADLs), particularly in school contexts. Thus, when attending school, children and adolescents remain seated in incorrect postures for long periods in the classroom, which, combined with a tendency toward a sedentary lifestyle and inadequate transportation and/or excess weight in school backpacks, may contribute to postural changes and MSDs (Sedrez et al., 2015; Direção-Geral da Saúde, 2015). In a study of 1,463 students aged 9 to 19, half of the participants reported lower back pain at least once in their lives. Age, gender (female), body fat percentage, prolonged use of mobile devices and computers, hyperkyphosis, and overall lateral curvature of the spine to the left were identified as factors associated with a higher relative risk of low back pain (Azevedo et al., 2023). Another study conducted in 2024 with 268 students ($M = 12.21$ years) concluded that, regarding postural habits and their relationship with back pain, 78.8% of participants had poor posture. These participants reported a higher mean intensity and frequency of pain (1.58 and 1.84, respectively) than those with what was considered ideal posture (1.40 and 1.62, respectively; Desouzart & Filgueiras, 2024). Therefore, investigating the prevalence of MSDs in childhood and adolescence and identifying risk factors that may contribute to their onset in a school context is a challenge for health professionals in conjunction with schools (Martins et al., 2020). The lack of validated instruments in Portuguese to dynamically assess the postural habits of preadolescents in school contexts provided the opportunity to design this study and contribute to filling this gap in theory and practice. The LADy appeared to be an appropriate instrument for this purpose, since it assesses dynamic posture in various ADLs and considers, in a qualitative and more in-depth manner, the different aspects that can affect body posture in motion (Antoniolli et al., 2015).

Methodology

A methodological study was conducted and structured into three phases: translation and cross-cultural adaptation, pretesting, and an exploratory study to analyze the psychometric properties of LADy, following the international guidelines proposed by Beaton et al. (2020). This research is part of a PhD project in Nursing, registered at the Center for Interdisciplinary Research in Health and approved in March 2019 by the Regional Scientific Committee of the Faculty of Health Sciences and Nursing of the *Universidade Católica Portuguesa*.

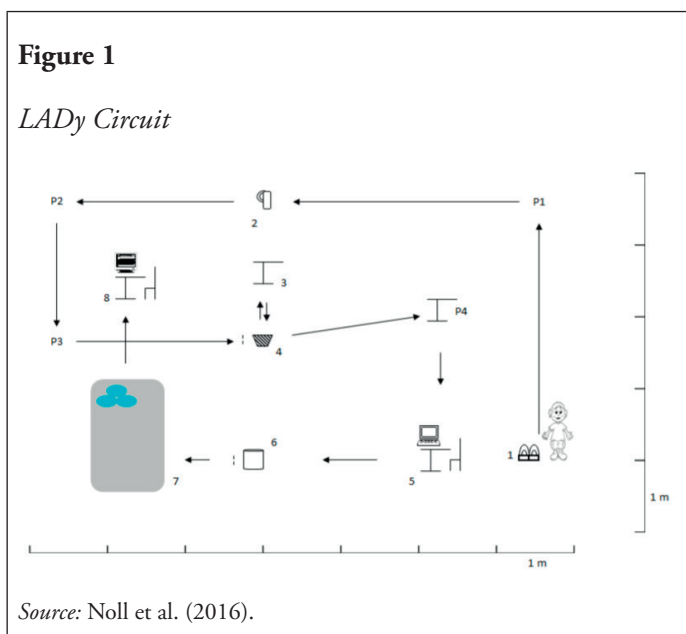
Data collection instrument

LADy is a low-cost, English-language instrument created by a team of researchers in Brazil to assess dynamic posture in school contexts. It is intended to complement static posture assessment using other instruments, such as

the Back Pain and Body Posture Evaluation Instrument, developed by the same authors (Noll, Candotti, Vieira, & Loss, 2013) and validated in Portuguese preadolescents by Matos et al. (2025). Together, these instruments provide additional information to support interventions in school-based posture education.

LADy consists of a video recording of a circuit of nine ADLs (Figure 1): *transportar sacos* [carrying bags] (1 + P1), *transportar uma mochila escolar* [carrying a school

backpack] (2 + P2 + P3), *sentar numa mesa para escrever* [sitting at a desk to write] (3), *levantar um objeto do chão* [lifting up an object from the ground] (4), *transportar um objeto* [carrying an object] (P4), *sentar numa mesa para usar um computador portátil* [sitting at a desk to use a portable computer] (5), *sentar numa cadeira sem encosto* [sitting on a seat with no back support] (6), *dormir* [sleeping] (7), and *sentar numa mesa para utilizar um computador* [sitting at a desk to use a desktop computer] (8; Noll et al., 2016).



The instrument includes a manual describing the required materials, their layout, the sequence in which the exercises should be performed, and nine assessment sheets corresponding to each dynamic posture, along with reference images of standard postures (Noll et al., 2016). Each observed item is scored with 1 point in each ADL score, according to pre-established criteria (53 items in total; Noll et al., 2016).

The use of LADy depends on several requirements, including physical resources (space and materials), time (implementation of the circuit and analysis of dynamic postures), financial resources (for the purchase of the videography equipment), human resources (trained personnel), and, if possible, partnerships and educational projects to support this type of activity (Noll et al., 2016). Rater/researcher training is also essential to ensure the correct setup of the circuit and accurate analysis of dynamic postures.

Statistically, LADy is considered valid and reproducible, with the results of the intra- and interrater and test-retest procedures ranging from moderate to excellent ($k = 0.41-1$; Noll et al., 2016).

Translation and cross-cultural adaptation

Since LADy was originally developed in English, it was first translated by two official bilingual translators of Portuguese nationality with no prior knowledge of the instrument. Two members of the research team compared their two translations, and the instrument was adjusted

to ensure linguistic equivalence, resulting in the final translation.

The translated version was then back translated by two official bilingual translators of English nationality who were also unfamiliar with the original instrument. The two back-translated versions were analyzed and compared by two members of the research team to ensure equivalent interpretations. This back-translation was sent to the original authors for analysis and validation, and their approval resulted in the final back-translated version.

The first version of LADy-PT was developed by comparing all versions — the original, the final translation, and the final back-translation — followed by the necessary adjustments. To ensure the clarity, relevance, and cultural appropriateness of the items in the first version of LADy-PT (Portuguese version already adjusted, resulting from the process of translation, back-translation, and harmonization with the original version), the Delphi method was applied according to McPherson et al. (2018).

A panel of experts with recognized academic and professional experience in Rehabilitation Nursing, Child Health and Pediatric Nursing, Community and Public Health Nursing, School Health Nursing, and Nursing Research was invited to participate.

Experts received the original LADy and a questionnaire composed of three parts:

Part I – sociodemographic and professional characterization, degree of knowledge, and influence of sources of argumentation on the topic;

Part II – degree of agreement with the items in the first version of LADy-PT, according to the consensus levels proposed by Passos et al. (2013), using a 5-point Likert scale (1 = *disagree* to 5 = *totally agree*);

Part III – overall assessment of the instrument, suggestions, and comments.

Experts also assessed pertinence, relevance, usefulness, composition, writing, and clarity using a 5-point Likert scale (1 = *inadequate* to 5 = *very adequate*). After analyzing and statistically processing the responses and incorporating qualitative suggestions, the instrument was adjusted to ensure conceptual equivalence, resulting in the second version of LADy-PT.

Population and sample

The study population consisted of preadolescents aged 10 to 13 years ($n = 162$), attending the 5th and 6th grades at a 2nd/3rd cycle basic school in northern Portugal. Eligibility criteria included signed informed consent from parents or guardians, voluntary participation, and absence of physical or cognitive limitations that could hinder participation in the circuit.

A non-probabilistic convenience sampling method was used, following the recommendation to include at least five participants per item to psychometrically analyze the nine dynamic postures that compose LADy (Gunawan et al., 2021).

Validation was conducted in this age group because puberty typically begins at approximately age 10 in females and age 12 in males (Baptista et al., 2020). Diagnosing posture-related issues during this developmental phase allows for preventive interventions that promote musculoskeletal health in the school context.

Pretest

The pretest of the second version of LADy-PT was conducted in December 2022 with a group of preadolescents recruited by their class head teachers/ physical education teachers, who had characteristics similar to the study population. It was ensured that these students would not participate in the LADy circuit during the main data collection phase because their physical education classes occurred in the afternoon, whereas the LADy circuit was administered during the first and second morning periods.

Psychometric validation: procedures

Data collection took place between January and March 2023. The principal investigator (a nurse specialist in rehabilitation) and the school health nurse from the Community Care Unit (UCC) for that school cluster were present in all classes.

Before the participation in the dynamic posture assessment program, the investigator explained the purpose and procedures, including video recording. Body weight was measured so that each participant could perform the circuit with a backpack weighing 10% of their body weight (Matos et al., 2020).

The school provided a dedicated space for conducting LADy, where the dynamic posture assessment circuit was set up without external interference. Video recordings were

carried out during the first and second morning classes to maintain consistent conditions for all participants.

All recordings were made using the same equipment (two cameras and two tripods), consistently positioned to capture frontal and lateral views, following the LADy manual (Noll et al., 2016).

The data obtained were analyzed using appropriate statistical measures and the same psychometric procedures as the original LADy, employing IBM SPSS Statistics version 28.0.

To assess the instrument's reproducibility, two raters (rater 1 and rater 2) independently analyzed the recordings. Cohen's Kappa (k) was calculated for ordinal and nominal variables to assess the level of agreement between the raters, which was interpreted as follows: < 0 = insignificant; $0-0.20$ = weak; $0.21-0.40$ = reasonable; $0.41-0.60$ = moderate; $0.61-0.80$ = strong; and > 0.81 = almost perfect agreement (Fleiss et al., 2003). Values of $k \leq 0$ were established as criteria for rejecting items.

The significance level was set at 0.05.

Ethical considerations

Authorization from the original authors for the translation, cross-cultural adaptation, and psychometric analysis of LADy for Portuguese preadolescents was obtained in June 2018. The psychometric analysis of LADy was performed after authorization was granted by the coordinator of a UCC in northern Portugal in March 2022. A partnership was established with the school's health nurse (a nurse specialist in community health) from the UCC, who received training from the principal investigator on LADy application procedures.

A formal request was made to the Board of Directors of the school cluster covered by the UCC, and approval was obtained in June 2022. The study was presented to the head class teachers and the physical education teachers, the subject in which the conditions were created and the necessary steps were taken to collect the data.

Following the head class teachers' contact, students' participation was authorized by parents or guardians through informed consent.

Participants were informed of the study's objectives and procedures, including video recording, and were assured of their right to withdraw at any time. They were also invited to ask questions.

Confidentiality and anonymity were guaranteed.

Anthropometric measurements and the LADy circuit were conducted individually, respecting each student's privacy. Images and videos generated during LADy administration were pixelated when necessary for public presentation. This study was authorized by Opinion No. 41/2022, issued by a Health Ethics Committee in June 2022.

Results

Translation and cross-cultural adaptation

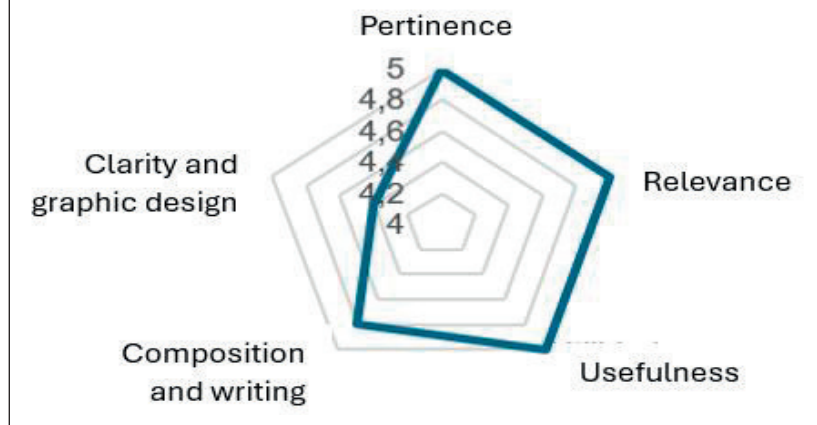
In the LADy translation process, only insignificant differences were found between the two versions obtained. The discrepancies identified were minimal and related exclusively

to words with multiple possible translations in Portuguese. During the back-translation stage, discrepancies were found regarding words or terms with multiple English translations between the two versions presented by the translators. This required the introduction of a third independent translator to resolve these differences. A final version of the back-translation was then obtained and approved by the original authors of the instrument. Next, a panel of five recognized experts in the field and on the subject in question was formed to assess agreement with the first version of LADy-PT. On average, these experts had 30.4 years (± 9.34)

of professional experience in their respective fields. Regarding the degree of agreement among the experts, all questions in the first version of the manual and the LADy-PT assessment forms had 100% agreement and were classified as a perfect consensus (Passos et al., 2013). Qualitative suggestions from the experts were incorporated, including the standardization of certain terms or expressions and improvements to the graphic design of the instrument. Regarding the pertinence, relevance, usefulness, composition, writing, clarity, and graphic design of the first version of LADy-PT, the mean of all parameters was rated above 4 (Figure 2).

Figure 2

Overall assessment of the second version of LADy-PT by the expert panel



Following these procedures, the second version of LADy-PT was obtained.

Pretest

The second version of LADy-PT underwent pretesting with eight preadolescents, who demonstrated good receptivity and adherence to the required tasks. The assembly of the circuit and the analysis of the video material, to meet the required criteria, improved as familiarity and experience increased. The location initially provided by the school (a sports hall) was not ideal, as other classes were taking place simultaneously, causing interruptions and noise. Consequently, the school provided another space that was

used exclusively for the final application of LADy. The raters' posture was also improved so as not to influence the preadolescents' performance of the tasks. The mean time for participants to complete the LADy tasks individually was set at 6 minutes, and 15 minutes were required for the research team to analyze and complete the assessment forms (front and side view).

Psychometric analysis

Fifty-nine preadolescents participated, with a mean age of 11.5 years ($SD = 0.7$), of whom 59.3% were male. Nine dynamic postures and 53 items were evaluated, of which 13 were statistically rejected (Table 1).

Table 1

Cohen's Kappa coefficient values for LADy items

POSTURE/Items		<i>k</i>	Std. Error ^b	<i>z</i> ^c	Lower limit	Upper limit	<i>p</i>	Decision
1 - TRANSPORTAR SACOS								
1	Transportar um saco em cada mão	1.00	0.00	7.68	1.00	1.00	< 0.001	include
2	Tronco ereto	0.40	0.13	3.14	0.15	0.66	0.002	include
3	Cabeça em posição neutra	0.16	0.13	1.29	-0.09	0.41	0.197	include
2 - TRANSPORTAR UMA MOCHILA ESCOLAR								
1	Transportar a mochila com uma alça em cada ombro	0.90	0.06	6.88	0.78	1.01	0.000	include
2	Tronco ereto	0.04	0.10	0.42	-0.16	0.25	0.677	include
3	Cabeça em posição neutra	0.42	0.11	3.95	0.20	0.63	0.000	include
3 - SENTAR NUMA MESA PARA ESCREVER								
1	Cabeça em posição neutra	-0.02	0.02	-0.19	-0.06	0.01	0.85	exclude
2	Tronco ereto	-0.02	0.02	-0.19	-0.06	0.01	0.850	exclude
3	Tronco a tocar no encosto da cadeira	0.41	0.12	3.90	0.17	0.65	0.001	include
4	Antebraços pousados na secretária	na ^a						include
5	Plantas dos pés apoiadas numa base ou no chão	0.64	0.13	5.08	0.38	0.90	0.001	include
6	Flexão da anca a 90°(±5°)	-0.04	0.05	-0.82	-0.14	0.07	0.410	exclude
7	Flexão dos joelhos a 90°(±5°)	0.31	0.12	2.50	0.07	0.54	0.012	include
8	Membros inferiores afastados (igual ou superior à largura dos ombros)	0.33	0.13	2.52	0.08	0.57	0.012	include
9	Ombros alinhados	0.24	0.11	2.07	0.01	0.46	0.038	include
4 - LEVANTAR UM OBJETO DO CHÃO								
1	Tronco ereto	0.13	0.13	1.13	-0.13	0.39	0.259	include
2	Objeto entre os pés	0.60	0.11	4.73	0.39	0.80	0.000	include
3	Flexão dos joelhos (≥90°)	0.40	0.16	3.09	0.09	0.70	0.002	include
4	Membros inferiores simétricos	0.31	0.13	2.41	0.05	0.57	0.016	include
5	Plantas dos pés assentes no chão	0.44	0.14	3.40	0.16	0.72	0.001	include
5 - TRANSPORTAR UM OBJETO								
1	Cabeça em posição neutra	0.20	0.11	1.77	-0.02	0.42	0.077	include
2	Tronco ereto	0.40	0.21	3.32	-0.01	0.82	0.001	include
3	Objeto a tocar no corpo	-0.05	0.09	-0.53	-0.23	0.12	0.594	exclude
6 - SENTAR NUMA MESA PARA USAR UM COMPUTADOR PORTÁTIL								
1	Cabeça em posição neutra	0.18	0.13	1.91	-0.08	0.45	0.056	include
2	Tronco ereto	0.38	0.12	2.94	0.15	0.62	< 0.001	include
3	Tronco a tocar no encosto da cadeira	0.57	0.13	4.83	0.31	0.82	0.000	include
4	Antebraços pousados na secretária	na ^a						include
5	Plantas dos pés apoiadas numa base ou no chão	0.66	0.14	5.17	0.38	0.93	0.000	include
6	Flexão da anca a 90°(±5°)	-0.03	0.10	-0.32	-0.23	0.17	0.751	exclude
7	Flexão dos joelhos a 90°(±5°)	0.61	0.10	4.84	0.41	0.81	0.000	include
8	Membros inferiores afastados (igual ou superior à largura dos ombros)	0.38	0.12	2.91	0.13	0.62	0.004	include
9	Ombros alinhados	0.00	0.00		0.00	0.00		exclude

7 - SENTAR NUMA CADEIRA SEM ENCOSTO								
1	<i>Tronco ereto</i>	0.48	0.12	3.90	0.23	0.72	< 0.001	include
2	<i>Plantas dos pés apoiadas numa base ou no chão</i>	0.52	0.17	4.21	0.19	0.85	< 0.001	include
3	<i>Flexão da anca a 90°(± 5°)</i>	0.12	0.08	1.94	-0.04	0.27	0.053	include
4	<i>Flexão dos joelhos a 90°(± 5°)</i>	0.43	0.16	3.68	0.12	0.75	0.000	include
5	<i>Membros inferiores afastados (igual ou superior à largura dos ombros)</i>	0.12	0.14	1.27	-0.15	0.39	0.205	include
6	<i>Ombros alinhados</i>	0.00	0.00		0.00	0.00		exclude
8 - DORMIR								
1	<i>Deitado de costas</i>	1.00	0.00	7.68	1.00	1.00	< 0.001	include
2	<i>Deitado de lado</i>	1.00	0.00	7.68	1.00	1.00	< 0.001	include
3	<i>Tronco ereto</i>	0.67	0.09	5.45	0.49	0.85	< 0.001	include
4	<i>Membros inferiores simétricos e alinhados com o tronco</i>	0.78	0.15	6.16	0.49	1.07	< 0.001	include
5	<i>Membros inferiores simétricos e semifletidos (ancas e joelhos)</i>	0.93	0.05	7.15	0.83	1.03	< 0.001	include
6	<i>Cabeça em posição neutra</i>	0.31	0.13	2.79	0.07	0.56	0.005	include
9 - SENTAR NUMA MESA PARA USAR UM COMPUTADOR								
1	<i>Cabeça em posição neutra</i>	0.01	0.19	0.05	-0.37	0.38	0.964	exclude
2	<i>Tronco ereto</i>	-0.15	0.20	-0.72	-0.53	0.24	0.469	exclude
3	<i>Tronco a tocar no encosto da cadeira</i>	-0.08	0.08	-0.68	-0.23	0.07	0.499	exclude
4	<i>Antebraços pousados na secretária</i>	0.05	0.15	0.33	-0.24	0.33	0.742	include
5	<i>Plantas dos pés apoiadas numa base ou no chão</i>	0.10	0.18	0.63	-0.25	0.45	0.53	include
6	<i>Flexão da anca a 90°(±5°)</i>	0.05	0.21	0.24	-0.35	0.45	0.809	include
7	<i>Flexão dos joelhos a 90°(±5°)</i>	-0.06	0.15	-0.38	-0.35	0.24	0.704	exclude
8	<i>Membros inferiores afastados (igual ou superior à largura dos ombros)</i>	-0.15	0.18	-0.83	-0.51	0.20	0.408	exclude
9	<i>Ombros alinhados</i>	0.00	0.00			0.00	0.000	exclude

Note. na* = It is not possible to calculate k because the values are constant; however, since the % agreement is 100, these items are included.

Given that most of the items inherent to dynamic posture no. 9 were excluded (six out of nine), it was decided to eliminate this criterion from LADy-PT, along with the respective items — both those included and those excluded. In posture no. 5, it was decided to include an item that was statistically rejected. Therefore, although 13 items were statistically rejected, a total of 15 items

were excluded (12 statistically rejected and 3 included in dynamic posture no. 9), resulting in a total of 38 assessment items distributed across eight dynamic postures. The final version of LADy-PT was presented to the original authors, who agreed with the validated version, which consisted of 38 assessment items distributed across eight dynamic postures (Table 2).

Table 2*Total number of final items per LADy-PT posture*

POSTURE/items	TOTAL OF ITEMS
1 - TRANSPORTAR SACOS	
1 Transportar um saco em cada mão	
2 Tronco ereto	3
3 Cabeça em posição neutra	
2 - TRANSPORTAR UMA MOCHILA ESCOLAR	
1 Transportar a mochila com uma alça em cada ombro	
2 Tronco ereto	3
3 Cabeça em posição neutra	
3 - SENTAR NUMA MESA PARA ESCREVER	
3 Tronco a tocar no encosto da cadeira	
4 Antebraços pousados na secretária	
5 Plantas dos pés apoiadas numa base ou no chão	
7 Flexão dos joelhos a $90^{\circ}(\pm 5^{\circ})$	6
8 Membros inferiores afastados (igual ou superior à largura dos ombros)	
9 Ombros alinhados	
4 - LEVANTAR UM OBJETO DO CHÃO	
1 Tronco ereto	
2 Objeto entre os pés	
3 Flexão dos joelhos ($\geq 90^{\circ}$)	5
4 Membros inferiores simétricos	
5 Plantas dos pés assentes no chão	
5 - TRANSPORTAR UM OBJETO	
1 Cabeça em posição neutra	
2 Tronco ereto	3
3 Objeto a tocar no corpo	
6 - SENTAR NUMA MESA PARA USAR UM COMPUTADOR PORTÁTIL	
1 Cabeça em posição neutra	
2 Tronco ereto	
3 Tronco a tocar no encosto da cadeira	
4 Antebraços pousados na secretária	7
5 Plantas dos pés apoiadas numa base ou no chão	
7 Flexão dos joelhos a $90^{\circ}(\pm 5^{\circ})$	
8 Membros inferiores afastados (igual ou superior à largura dos ombros)	
7 - SENTAR NUMA CADEIRA SEM ENCOSTO	
1 Tronco ereto	
2 Plantas dos pés apoiadas numa base ou no chão	
3 Flexão da anca a $90^{\circ}(\pm 5^{\circ})$	5
4 Flexão dos joelhos a $90^{\circ}(\pm 5^{\circ})$	
5 Membros inferiores afastados (igual ou superior à largura dos ombros)	

8 – DORMIR

1	<i>Deitado de costas</i>
2	<i>Deitado de lado</i>
3	<i>Tronco ereto</i>
4	<i>Membros inferiores simétricos e alinhados com o tronco</i>
5	<i>Membros inferiores simétricos e semifletidos (ancas e joelhos)</i>
6	<i>Cabeça em posição neutra</i>

6

Discussion

This study aimed to translate, cross-culturally adapt, and psychometrically analyze the LADy dynamic posture assessment layout for Portuguese preadolescents. The instrument was translated, back translated, and pretested, followed by a second phase to test its reproducibility through evaluation by two raters. The cross-cultural adaptation process complied with the proposed recommendations. The analysis of the items by experts and the pretesting phase were fundamental for standardizing the language and graphic design and for providing experience with the practical procedures inherent to the LADy. Psychometric analysis indicated that reproducibility for each item ranged from minimal to excellent ($k = 0.04$ to 1), whereas in the original version the results ranged from moderate to excellent (Noll et al., 2016). Postures no. 1 (*transportar sacos* [carrying bags]), no. 2 (*transportar uma mochila escolar* [carrying a backpack]), no. 4 (*levantar um objeto do chão* [lifting up an object from the ground]), no. 5 (*transportar um objeto* [carrying an object]), and no. 8 (*dormir* [sleeping]) were those with higher k coefficient values, consistent with the original version (Noll et al., 2016). In posture no. 2 (*transportar uma mochila escolar* [carrying a backpack]), assessment item no. 2 (*tronco ereto* [erect trunk]) obtained weak inter-rater agreement ($k = 0.04$). However, considering that forward inclination of the trunk's segment when carrying a backpack may place greater stress on the spine (ligaments and intervertebral discs) and increase the risk of back problems in this age group (Abbass & Abd-ul-Amir, 2017), it was decided to retain this item in the Portuguese version. Thus, to assess this dynamic posture, it is essential to verify whether the trunk is upright, following the literature on correct postural habits that respect body biomechanics when carrying school backpacks dynamically (Hall, 2021; Matos & Barreiras, 2021; Samakow, 2017). In posture no. 5 (*transportar um objeto* [carrying an object]), assessment item no. 3 (*objeto a tocar no corpo* [object touching the body]) was statistically excluded ($k = -0.05$), but it was retained in the final Portuguese version because the correct technique for carrying an object and preventing MSDs requires the load to be as close as possible to the individual's body (Decree-Law No. 330/93, 1993; European Union, 2007; Rebelo, 2017). Items related to sitting postures (no. 3 – *sentar numa mesa para escrever* [sitting at a desk to write]; no. 6 – *sentar numa mesa para usar um computador portátil*

[sitting at a desk to use a portable computer]; no. 7 – *sentar numa cadeira sem encosto* [sitting on a seat with no back support]; and no. 9 – *sentar numa mesa para usar um computador* [sitting at a desk to use a desktop computer]) obtained the lowest k coefficient values, consistent with the original version (Noll et al., 2016). These results may be explained by the number of sitting postures required in the circuit, during which participants may already be experiencing some fatigue. Specifically regarding posture no. 9 – *sentar numa mesa para usar um computador* [sitting at a desk to use a desktop computer]), the statistical data were weak, indicating little agreement among raters and resulting in a higher number of excluded items (6 out of 9). This led to the decision to eliminate this criterion from LADy-PT, along with all respective items (both those excluded and included). One possible explanation is the decreasing use of desktop computers in favor of laptops or other mobile devices (Gaspar et al., 2022). However, in the LADy-PT version, the assessment of this posture is not compromised, since the elimination of posture no. 9 does not affect the ability to assess dynamic sitting posture for laptop use (posture no. 6 – *sentar numa mesa para usar um computador portátil* [sitting at a desk to use a portable computer]").

Limitations, suggestions, and future directions

A limitation of this study is the absence of statistical testing for criterion validity and concurrent validity, due to the lack of a comparable established instrument capable of evaluating similar constructs and enabling result comparison.

Another limitation relates to the use of video recording as a data collection technique. Although video analysis enables detailed observation and review of the dynamic postures adopted by preadolescents during routine school activities (e.g., sitting, carrying backpacks), participants may temporarily adjust their posture because they are aware of being filmed. Nonetheless, video recording made it possible to capture dynamic postures in classroom environments that may not be fully represented in self-administered questionnaires and to identify postural patterns more objectively compared to questionnaires or direct observation.

It is recommended that future studies apply the LADy instrument to additional age groups and include the development and validation of criteria for assessing dynamic posture during mobile device use. Furthermore, the LADy layout should be used in longitudinal studies or research requiring repeated assessments. For this pur-

pose, the evaluation circuit must be organized in strict accordance with the instruction manual and assessment forms, with adequate planning of all logistical requirements, including physical space, appropriate recording equipment, financial support, and time allocation. It is also imperative that raters receive theoretical and practical training in the use of LADy-PT.

Conclusion

The translation, cross-cultural adaptation, and psychometric analysis of the LADy dynamic posture assessment layout demonstrated that the Portuguese version (LADy-PT) is suitable for use with preadolescents in school contexts.

Psychometric results indicated that LADy-PT is a reliable instrument, showing reproducibility levels consistent with those of the original version. Of the nine dynamic postures and 53 evaluation items in the original instrument, eight postures and 38 items were retained in the Portuguese version.

LADy-PT is a valid and reproducible instrument for assessing dynamic postures in preadolescents, provided that the application guidelines are strictly followed.

In clinical practice, it complements methods for evaluating postural habits and static posture by enabling the early detection of dynamic posture patterns during ADLs. This contributes to a more realistic understanding of school-context behaviors, which involve alternating between movement and prolonged sitting.

This approach is especially relevant at school age when the implementation of postural education initiatives by school health teams in collaboration with educational stakeholders can prevent future musculoskeletal problems. The instrument can also facilitate comparative analyses across different time points, such as before and after a postural education intervention.

By enabling assessment outside of laboratory conditions — and through a circuit that can be perceived as an educational activity — LADy-PT supports the evaluation of postural behavior in children and preadolescents in school environments. In teaching and research contexts, the instrument fills a methodological gap at the national level, complementing static posture assessment instruments and self-report questionnaires. Moreover, the use of video provides a permanent record that enhances inter-rater reliability and supports educational activities, professional training, and future investigations.

The implementation of LADy-PT has the potential to generate stronger scientific evidence on postural habits and dynamic posture, enabling international comparisons and supporting the development of evidence-based interventions.

Thus, the introduction of LADy-PT in Portugal represents not only a methodological advance but also an opportunity to strengthen the connection between clinical practice, research, and education, contributing to a more comprehensive and integrated approach to postural health promotion during school age.

Thesis/Dissertation

This article is derived from the dissertation entitled “Postural Habits and Back Pain in Pre-Adolescents”, developed at the Portuguese Catholic University, Faculty of Health Sciences and Nursing, and currently ongoing.

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