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Development of a health-tracking tool for the Brazilian population: a pilot study with Brazilian women

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Abstract

Background Mobile apps can promote different behavioral interventions, thus decreasing preventable health problems. Challenges persist in ensuring the quality and reliability of these applications, as few have undergone rigorous scientific evaluation. Additionally, few scientifically validated questionnaires on well-being, adapted for the general public, are available in the literature. The objective of this study was to test and validate a general health assessment instrument based on questionnaires available in the literature, previously validated for the Brazilian population.

Methods The tracking tool was tested with healthy women, 18 to 50 years old. The instrument was constructed as a 29-question online form comprising 5 main clusters or "pillars" of individual health: general health, diet and nutrition, movement and activity, sleep, and mental health. The original and adapted versions of two sections (Sleep and Mental Health) were applied in a subsample of participants to compare intra-individual variability. Data from the "Mental Health" and "Sleep" sections were rigorously tested for normality and Pearson's correlation test was performed to compare the results of the original and adapted versions intra-individually. Chi-Square and McNemar tests were employed to pair categorical data and account for correspondence between the answers to the two forms of the questionnaires.

Results Seventy-one women answered the instrument with the proposed adapted versions of the questionnaires. The average completion time was between 12–20 min. The mean scores of the diet, movement, and general health questionnaires were similar to those of the original questionnaires from which questions were taken. The "Sleep" and "Mental Health" exhibited intra-individual divergences concerning the classification of results. The correlation between the original and adapted versions was improved after revising some of the questions ($r = 0.9287$; $p < 0.0001$).

Conclusion The results of the present study demonstrate that this adapted instrument is valid and reliable for assessing the intended five pillars of health. Studies with larger sample sizes and other populations are encouraged.

Keywords Mobile applications, Mobile health, Questionnaires, Pillars of health

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Background

A growing range of mobile applications aimed at health promotion are currently available for download [1]. Nonetheless, challenges persist in ensuring the quality and reliability of these apps [2]. To address these barriers, continuous quality assessment and assurance systems are essential. Few instruments used in these applications have undergone rigorous scientific evaluation to ensure actual and adequate validity [3–5] and prevention of misinformation and health risk issues.

In recent years, technological advances in connectivity, wearable devices such as smartwatches or heart rate sensors, and artificial intelligence algorithms have transformed health monitoring, allowing a more personalized approach. Additionally, enhanced data privacy and security measures have enabled the development of robust and accurate healthcare apps with significant potential to improve disease prevention, diagnosis, and treatment accessibility [6, 7].

The increased access to these applications has changed how patients interact with the healthcare system. It is now possible to access personal health data quickly and conveniently, schedule virtual appointments, manage medication dosages, and promote well-being, among other advantages [8, 9]. By combining these features with active user participation, mobile applications can offer behavioral intervention, potentially contributing to reducing preventable health problems and enabling users to adopt healthier lifestyles [9]. Furthermore, e-health interventions have been proven to be comparable to in-person interventions and more effective than no-care or control interventions [10].

Studies demonstrate that behavior changes are associated with better results when self-monitoring and progress assessment toward a goal are available [11–13]. Self-monitoring tends to have a positive impact, whether in weight loss or in preventing behavioral diseases. The results are superior when combined with other measures, such as goal setting and individualized feedback, as these prospects warrant engagement and commitment to goals [14–16].

However, many health and fitness-related mobile applications lack validation for assessing physical fitness [3] and for reliable clinical and health purposes [4], such as the control of obesity and body composition [5]. Furthermore, a few scientifically validated questionnaires adapted for the general public are available in the literature [17], raising a pressing need for proper scientific evaluation. In 2021, approximately 350,000 healthcare apps were available on the global market [18]. In the same year, Sedhom and colleagues [19] assessed the validity of 22 popular mobile oncology health apps and reported their limited clinical value, raising awareness of the fact that these applications are boundlessly available and present great influence on individual lifestyle choices of the lay public.

All this considered, the objective of this study was to test the feasibility of the application of a general health assessment instrument based on previously validated questionnaires in the Brazilian population. This health-tracking instrument could serve as a prototype for the development of scientifically based online applications, thus providing individuals with means to assess the quality of general health aspects and the adequacy of their lifestyle choices.

Methods

Eligibility criteria

The present study was approved by the ethics committee of the Faculty of Medicine of the University of São Paulo nº 6.690.907. All ethical procedures were in accordance with the Declaration of Helsinki. Participants in this study were recruited through online outreach strategies, including targeted email campaigns and social media postings. The sample consisted of 71 women who voluntarily responded to one of these digital invitations. The emails were sent to contact lists, while social media was used to expand the reach of the research through posts in relevant groups and networks. All interested had access to the electronic form and signed a digital informed consent form (ICF), which clearly outlined the study's objectives, emphasized the voluntary nature of participation, and assured confidentiality of the collected data. After reading and accepting the ICF, participants completed the online questionnaire using Google Forms. This approach allowed for efficient and ethical recruitment of volunteers, respecting the previously established inclusion criteria.

The target population was healthy women ranging from 18 to 50 years old. These inclusion criteria were based on data revised by Karim and Talhouk, 2021 [19] which suggested that women from urban areas tend to be more inclined to use online health tracking instruments. Since one of the objectives of the present study was to test the volunteers' adherence to the instrument format, we focused on this population to avoid gender-based bias. Women with a history of irregular menstrual cycles due to menopause were excluded because of characteristic changes during this period, such as sleep problems, weight fluctuations, anxiety, mood changes, and others.

Tool design and data collection

The design of the in-development instrument has been previously described by Pimentel and colleagues, 2023 [20]. Briefly, it is based on previously validated questionnaires and health evaluation studies performed with the

Brazilian population, comprising 5 main clusters or "pillars" of individual health according to lifestyle medicine [21]: general health, diet, movement, sleep, and mental health (Fig. 1). Each one of the pillars represents one section of the entire tool. The validated questionnaires were used in their original form or an adapted format and applied sequentially according to the order shown in Fig. 2. The tiers included are the following:

- *The pillar of General Health and the pillar of Diet*: both sections were based on the health evaluation study performed by Höfelmann and Blank (2007) [22]. The general health questionnaire included in our tool consisted of an adapted, 5-question version of the original one used in the aforementioned study. For the diet section, the original format of the questionnaire was used in our tool.
- *The pillar of Movement*: this section consisted of the short version of the International Physical Activity Questionnaire (IPAQ), which estimates the individual energy expenditure based on the total amount of time dedicated to performing vigorous, moderate, and light physical activity. The short IPAQ has been validated in Brazil by Hallal and colleagues (2012) [23].
- *The pillar of Sleep*: this section is an adapted, 5-question version of the Mini-Sleep Questionnaire (MSQ), used for the populational screening of sleep disturbances and originally validated in the Brazilian population by Falavigna and colleagues (2011) [24].

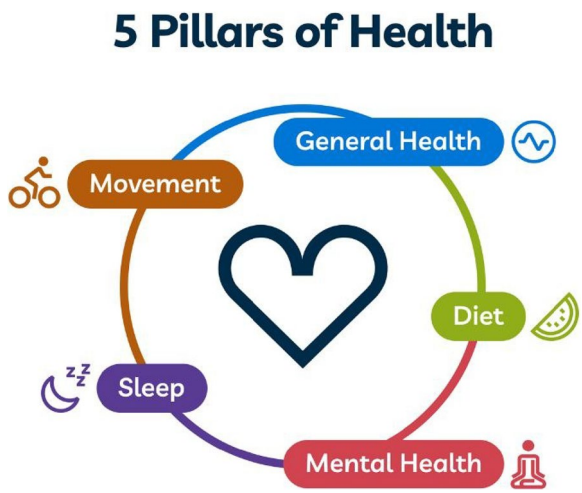

Fig. 1 The health-tracking instrument of our study focuses on assessing 5 dimensions of general health according to lifestyle medicine. Each of the 5 "pillars" of health represents one of the sections of the instrument

- *The pillar of Mental Health*: an adapted 5-question version of the Personal Health Scale validated by Zubaran and colleagues (2007) [25] was included as one of the sections of our tool. The scale aims to allow self-assessment of general well-being.

Convenience sampling was carried out by two of the researchers who were responsible for disseminating the tool as an online 29-question form using either messaging apps or through email exchange. The tool was available for completion by the volunteers for approximately two weeks, from March 12th to March 25th, 2024. After this trial period, the same researchers tabulated each participant's results independently, to assess the tool's feasibility and intelligibility, as it included three adapted versions of previously validated questionnaires. The original versions of the adapted sections were also applied in a subsample of around 36.6% of the participants to compare intraindividual variability.

Data analysis

All data were compiled in Excel® spreadsheets. The demographic data were analyzed using descriptive statistics. The data from the "Mental Health" and "Sleep" sections were rigorously tested for normality with the Shapiro–Wilk and Kolmogorov–Smirnov tests. Pearson's correlation test was performed to compare the results of their original and adapted versions intra-individually, as previously demonstrated in studies aiming to validate adapted versions of health [26]. These tests were chosen for their robustness and significance in the field of research methodology, ensuring the validity of our findings. Statistical analyses were performed using GraphPad Prism® 8.

To evaluate the internal consistency of the questionnaires associated with the five pillars, we conducted a reliability analysis by calculating both Cronbach's α and McDonald's ω. Additionally, we performed reliability assessments for all possible domain combinations of the questionnaires. Cronbach's αcoefficients ≥ 0.7 were considered reliable. The ci.reliability() function of the R package MBESS was used for this analysis. The Chi-Square and McNemar tests were used to pair categorical data and account for agreements and disagreements between the answers to the two questionnaires. p-value < 0.05 was considered statistically significant for all results.

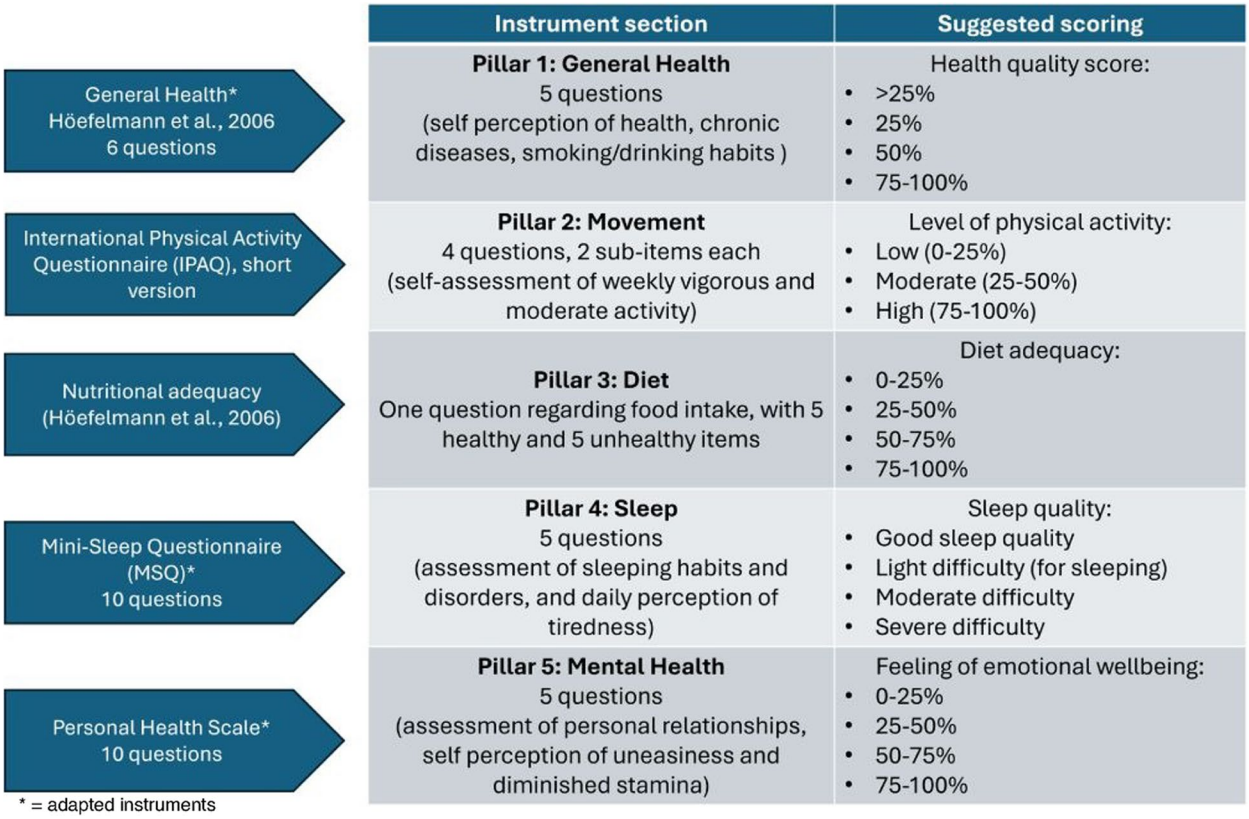

Fig. 2 Design of the health-tracking instrument. The tool comprises a 29-question form in which each section has its own scoring system adapted for the lay population. The original questionnaires (in blue) that were adapted to shorter versions are marked with a *

Results

The flowchart of the present study is shown in Fig. 3. A total of 71 women answered the instrument with the adapted versions of the questionnaires. The average age was 32 ± 8.2 years, with the majority (62%) of self-declared Caucasian/white Latino profile and complete higher education (71.83%). The average weight was 69.51 ± 14.37 kg with an average body mass index of 26.24 ± 5.02 kg/m^2, indicating an overweight population (Table 1). The average completion time was between 12–20 min.

After collecting data from the five adapted questionnaires ($n = 71$), a subsample of 26 volunteers (36.6%) was randomly generated to respond to the original questionnaires. These data were used to verify whether the adapted questionnaires were representative of the original ones. Table 1 presents comparative data regarding the sociodemographic characteristics of both samples.

There was no statistically significant difference between the demographic data of the total sample ($n = 71$) and the subsample data ($n = 26$).

The mean scores of the diet, movement, and general health questionnaires were similar to those of the

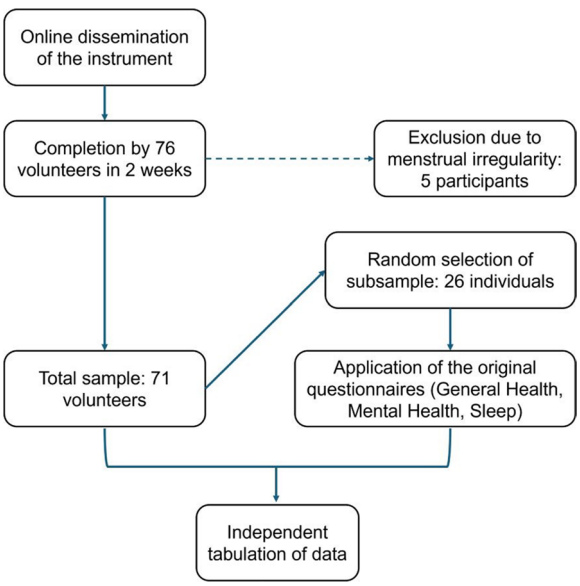

Fig. 3 Flowchart of the pilot study. Seventy-one volunteers were included, and a random subsample ($n = 26$) was assigned for completion of the questionnaires in their original format

Table 1 Sociodemographic data of the participants

	Total ($n=71$)	Sample ($n=26$)	*p*-value
Age (years)	32 ± 8.2	32.9 ± 8.3	0.9907
Ethnicity (%)			
Multiracial	23 (32.4)	10 (38.46)	0.25
Caucasian	44 (62)	15 (57.690	
Asian	3 (4.2)	1 (3.85)	
Other	1 (1.4)	-	
Education (%)			
High school	12 (16.9)	2 (7.69)	0.44
Incomplete High school	1 (1.41)	-	
Undergraduate	51 (71.83)	21 (80.77)	
Incomplete undergraduate	7 (9.86)	3 (11.54)	
Anthropometric measurements			
Weight (kg) mean ± SD	69.51 ± 14.37	71.36 (16.46)	0.7287
Height (m) mean ± SD	1.63 ± 0.06	1.63 (0.06)	0.8160
BMI (Kg/m^2) mean ± SD	26.24 ± 5.02	26.95 (6.02)	0.8571

original questionnaires. However, the questionnaires that assessed sleep and mental health exhibited intraindividual divergences concerning the classification of results. Correlation analysis was performed between the adapted sleep and mental health questionnaires and their respective original versions.

In the adapted sleep assessment (1st version), the correlation with the original questionnaire form was $r=0.6735$ ($p<0.0002$), indicating a moderate correlation (Fig. 4A). Following an analysis of the original questionnaire, we revised some questions while maintaining their total number, resulting in an improved correlation of $r=0.9298$ ($p<0.0001$) for Sleep Assessment 2 (2nd version) (Fig. 4B). No changes were necessary for the mental health assessment, as the adapted form already exhibited a strong correlation with the original questionnaire, $r=0.9287$ ($p<0.0001$) (Fig. 4C).

The "Mental Health" questionnaire alone had the highest α (0.79) and ω (0.79) values, indicating high reliability and high internal consistency. When the "Sleep" domain was added, the questionnaires maintained stable reliability (α = 0.78, ω = 0.79) (Table S1, Supplementary Material). The "Diet + Mental Health" questionnaire presented the largest difference between coefficients (α = 0.59, ω = 0.71). In some combinations, such as "General Health + Sleep + Mental Health", ω was higher than α (0.72 vs. 0.68), suggesting that there may be factors influencing reliability.

Discussion

This pilot study aimed to test a simplified, general health assessment instrument involving health parameters based on the adaptation of questionnaires validated for the Brazilian population. The included instruments were selected based on pre-established criteria [18] such as previous validation in Portuguese and the Brazilian population; clear and non-double labeling questions, with easy scoring; short or adapted versions that could be used in app-based online tracking tools and required a maximum of 20 min for completion.

While numerous reviews have explored methods and standards for assessing health apps, the issues surrounding the scoring and validity of these methods remain largely unverified [27–30]. The absence of a universally accepted 'gold standard' for evaluating these applications, particularly in terms of their structure, security, reliability, and usability, is a pressing concern, especially for the Brazilian population.

This instrument was idealized to be practical, easy to use, and low-cost, with a focus on reaching large population groups. In our correlation analysis, we demonstrated that the shorter, adapted versions of the validated questionnaires were representative of the originals.

The adapted versions of the diet, movement, and general health surveys showed no changes in results compared to the original versions of the validated questionnaires. However, the modified questionnaires that addressed sleep and mental health showed lower correspondence of results, compared to the original instruments.

Correlation analysis was conducted between the questionnaire responses provided by the full sample and the subsample. The adapted version of the mental health questionnaire exhibited a robust and statistically significant correlation with the original extended version ($r=0.9827$; $p<0.0001$). On the other hand, the adapted version of the sleep questionnaire revealed a moderate but significant correlation ($r=0.6735$; $p<0.0002$).

To improve the accuracy of the data and the congruence between the adapted and original versions, the questions in the adapted sleep version were reformulated, resulting in a second version that maintained the initial number of questions. The Pearson correlation for this second version indicated a strong and significant association ($r=0.9298$; $p<0.0001$), which suggests an improvement in the evaluation parameters and greater fidelity concerning the original questionnaire.

Reliability analyses were performed, and results suggest that the questionnaire items exhibit varying factorial weights, with McDonald's ω serving as a more robust reliability indicator than Cronbach's α. The inclusion of additional domains tends to lower reliability, likely due to increased response variability. Shorter, more focused questionnaires demonstrate higher internal consistency (Table S1 and S2), indicating greater reliability when questionnaires are administered individually or in small,

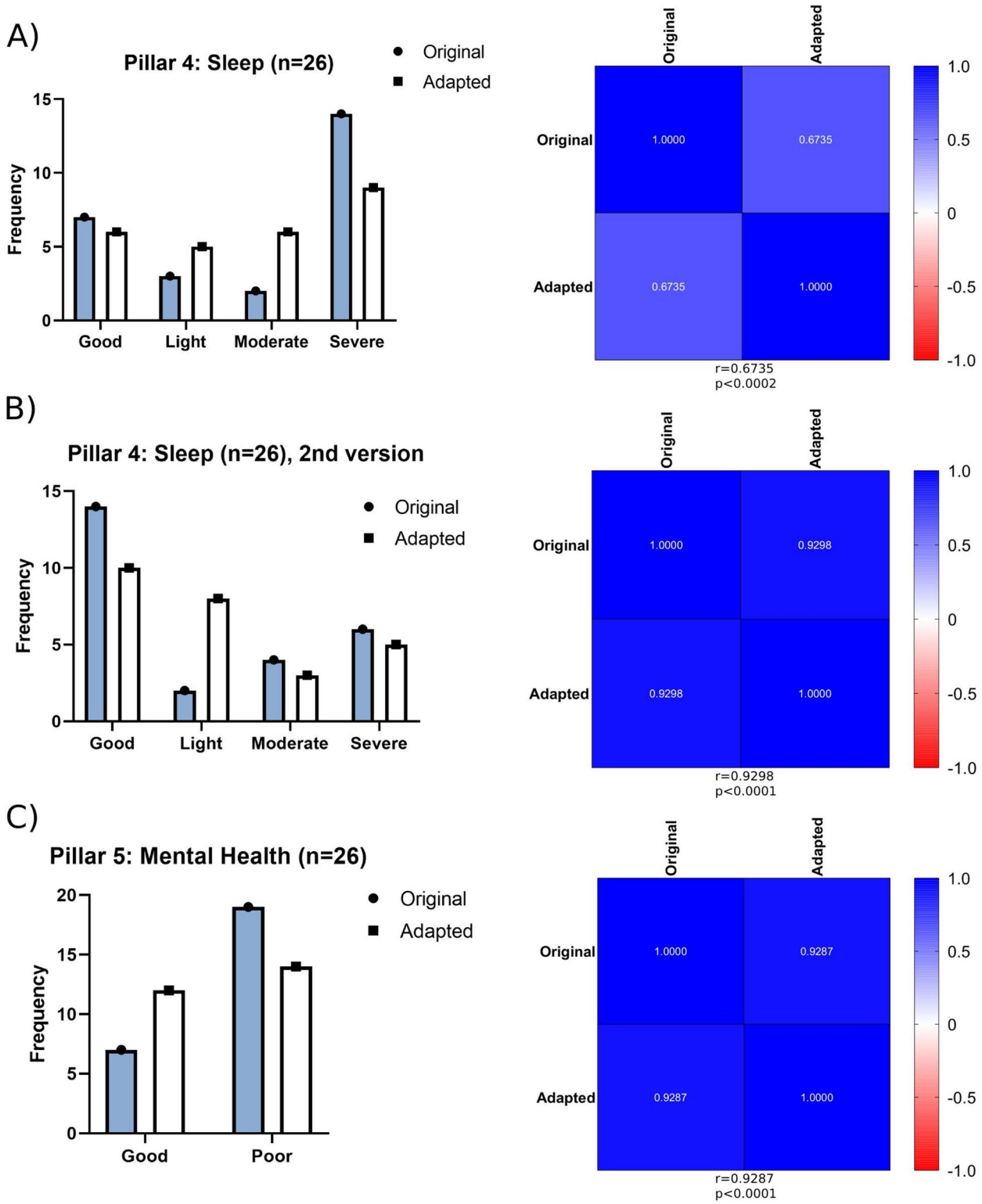

Fig. 4 Comparison and correlation analysis of the adapted and original versions of the questionnaires. **A** Frequencies of scores for the 1st version of the adapted Sleep questionnaire with a moderate correlation with those of the original version ($r = 0{,}67$). **B** Frequencies of scores for the 2nd version of the adapted Sleep questionnaire with a strong correlation with those of the original version ($r = 0{,}92$). **C** Frequencies of scores for the adapted version of the Mental Health questionnaire had a strong correlation with the original instrument ($r = 0{,}93$)

well-defined combinations. Also, increasing the sample size is recommended to reduce the gap between Cronbach's α and McDonald's ω values [31], which reinforces the need for further studies concerning our in-development tool.

Considering the potential harm that certain tools may pose to users, it is crucial to reinforce the importance of rigorous validation and the provision of empirical evidence regarding the efficacy of health applications [32].

Health and well-being assessment tools are essential for identifying health risks and poor lifestyle habits, allowing healthcare professionals to guide users toward healthy and preventative choices [33–36]. While there are challenges in validating and recommending health apps, the benefits to consumers and the healthcare system are considerable. Overcoming low reliability is crucial to ensuring that only safe and effective apps are recommended, elevating the quality of healthcare and patient outcomes [34, 37, 38]. The present tool was found to be reliable and adequate for the purposes intended and for the specific population.

One must bear in mind, nevertheless, that virtual tools should not be employed to diagnose or replace in-person medical consultations. Instead, they should complement and assist users in education, awareness, self-monitoring, self-care, disease management, and prevention, without overwhelming healthcare resources.

This study has several limitations that warrant consideration. Firstly, the small sample size, comprising 71 women aged 18 to 50 years, limits the generalizability of the findings to broader populations. Since the target population was selected based on previously established criteria concerning adherence to the type of tool we intend to develop [19], this reduced considerably the sample size of our study. Additionally, the absence of male participants and a gender-based analysis further restricts the study's scope, as potential differences between sexes are not accounted for. To enhance the validity and applicability of future research, it is imperative to include larger and more diverse samples, with deliberate attention to gender differences. Incorporating in-person assessments alongside online questionnaires could also mitigate biases related to disparities in digital access and literacy. Finally, longitudinal studies are recommended to assess the reliability and predictive validity of these modified questionnaires, ensuring their applicability across diverse contexts.

Conclusions

In summary, the final format of our in-development tool was well accepted by the target population, with a short completion time of 20 min for the entire 29-question form. The randomly selected subsample ($n = 26$) was demographically representative of the complete sample ($n = 71$), and intraindividual variability was observed for the results of the adapted mental health and sleep questionnaires when compared to their original versions. For the sleep questionnaire, some questions were revised and repositioned while maintaining their total number, resulting in an improved correlation ($r = 0{,}93$). For the mental health questionnaire, although the frequencies for each score diverged between adapted and original versions, a strong correlation was observed ($r = 0{,}93$). The results of the present study demonstrate that this adapted instrument is valid and reliable for assessing the five pillars of health, comparable to the original extended version of the questionnaires validated for the Brazilian population. Studies with larger sample sizes and including other genders are encouraged.

Abbreviations

ICF Informed consent form
IPAQ International Physical Activity Questionnaire
MSQ Mini-Sleep Questionnaire

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22102-x.

Supplementary Material 1

Author's contributions

CVMBP, AFCT and JPNR were responsible for project and instrument conception, and discussion of results. LPL participated in instrument conception and validation, and discussion of results. GG and AFR performed the reliability analysis in the present pilot study. MFA and MCC were involved in instrument application, analysis and discussion of results, and article writing.

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Data availability

Availability of data and materials.

Declarations

Ethics approval and consent to participate

This study is in accordance with Resolution 466/12 of the Brazilian National Health Council. Approval was obtained by the Research Ethics Committee of the Faculdade de Medicina da Universidade de São Paulo (6.690.907). All participants signed a digital informed consent form.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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