Original Article

Mobile Technologies for Monitoring Sleep Time: A Systematic Search of App Stores in Brazil

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Sleep Sci

Abstract

Introduction Decreased sleep time is detrimental to physical and mental health, exerting negative impacts on daily functioning and quality of life. Mobile health (mHealth) applications can be useful for improving sleep quality.

Objective To perform a systematic search of mHealth applications for monitoring sleep time at Brazilian online stores and evaluate the selected applications in terms of engagement, functionality, aesthetics, and quality of information.

Methods A systematic search was performed at the Google Play Store and the App Store developed or updated between 2020 and 2022. The mobile app rating scale (MARS) was used to assess their quality. The characteristics and information of these applications were presented. Data were analyzed descriptively.

Results Among the 2,264 relevant mHealth apps identified, 11 were eligible for inclusion. There was one app that offered only sleep time recordings, three offered sleep recordings and educational content, three monitored sleep time with audiovisual resources, two offered sleep time recordings with a focus on monitoring snoring, and two offered sleep time monitoring with individual content customizations. The apps scored fair on MARS, with a mean of 3.5 points (standard deviation: 0.8) on a scale of 1 to 5. Most apps scored low due to poor evidence-based information, aesthetics, and engagement.

Conclusion Although the use of mHealth technologies for monitoring sleep time has considerable potential for investigation, it is a relatively new, underexplored topic. Collaboration between researchers, clinical professionals, patients, and application developers is necessary for the creation of new evidence-based mHealth applications focused on Brazilian users.

Keywords
- public health
- mobile applications
- e-Health
- sleep
- sleeping habits

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Introduction

Decreased sleep time is harmful to physical and mental health and may be associated with changes in the normal functioning of the hypothalamic-pituitary-adrenal axis, thereby exerting an influence on stress response.[1] Moreover, inadequate sleep can trigger obesity by favoring an increase in the ratio between the hormones leptin and ghrelin and, consequently, appetite and hunger.[2] As a result, altered sleep can reduce quality of life and cause complications, such as increased daytime sleepiness and poor work performance.[3]

Sleep assessment has been a target of health application developers and a variety of programs with different functionalities are offered. Although the algorithms provide data regarding the structure of sleep, there is not a great deal of focus on scientific evidence.[4]

Consumer sleep technologies (CSTs) are broad computer-based systems available to the public for the purpose of improving the self-monitoring of sleep. Mobile applications running on smartphones and tablets are the most popular CSTs, as they do not require sensors and may include sleep tracking, alarm functions, and sleep-related recordings.[5] With the widespread adoption of smartphones by the general public, there is a growing interest in such applications. Thus, knowledge on the most common programs and their characteristics is necessary to guide users.[4]

Mobile health (mHealth) applications are defined as a means of medical and public health practice, available on mobile devices such as cellphones, personal digital assistants, and other wireless devices.[6,7] Thus, they can be used as a tool with functionality to perform tasks in different areas of interest, such as wellness management, health data collection, patient reminders etc.[8]

The systematic evaluation of the quality of applications can be performed using the mobile application rating scale (MARS), which establishes parameters such as engagement, functionality, aesthetics, information quality, and subjective application quality scores.[9] Based on MARS, Choi et al.[10] found that few mHealth apps available at online stores in the United States meet the pre-established criteria of quality, content, and functionality.

To the best of our knowledge, there are no scientific studies that systematically evaluate the quality of applications with the function of counting sleep hours for Brazilian consumers. Furthermore, some studies evaluated applications developed in a foreign language, which may be a barrier for the Brazilian population.[4,5,10]

Thus, the aim of the present study was to perform a systematic search of online stores available in Brazil (Google Play Store and App Store) for mHealth applications designed for monitoring sleep time, and to evaluate their engagement, functionality, aesthetics, and quality of information. The findings can inform healthcare providers, clinical researchers, patients, and other users regarding the best mobile technology applications available in Brazil for monitoring sleep time. The results may also serve as a guide for the development of new sleep applications.

Methods

The Preferred Reporting Items for Systematic Reviews and Metanalyses (PRISMA)[11] were followed but adapted to suit the systematic search of app stores, as in similar studies.[12,13] Ethical approval was not necessary, as this study did not involve human subjects. The review was not registered.

Search Devices and Strategies

The search for mobile applications for monitoring sleep time was performed in the Google Play Store (Google LLC., CA, USA) and App Store (Apple Inc., CA, USA) using a Galaxy Note20 Ultra 5G (Samsung, South Korea) Android device, system version Android 12, and an iPhone XR (Apple Inc., CA, USA), system version iOS 15.3.1. The App Store offers almost two million applications available worldwide.[14] Both stores together account for 99.2% of the system market share of global operations, with the participation of the Google Play Store in the Brazilian market corresponding to 57.1%.[15]

The terms used in both stores were the same and directly related to sleep monitoring. The keywords used were "sleep," "sleep monitor," "sleep technology," "sleep application," "hours of sleep," and "sleep quality." These keywords were searched in Brazilian Portuguese.

Inclusion and Exclusion Criteria

Only applications that worked independently of external devices and did not require add-ons beyond their operating vehicle were included.[16] Those that had the option of using the Portuguese language aimed at monitoring sleep and providing data regarding user sleep time were included.

Furthermore, applications with no Portuguese description at the online stores and those aimed only at advertising products or companies were excluded. Those not developed or updated between 2020 and 2022 were also excluded, as updates ensure software functionality and user support.[16]

Screening

Two independent researchers reviewed the mHealth apps. A third reviewer was available to settle any disagreements. In the presence of two identical applications on both platforms (iOS and Android), the iOS version was selected. Two applications had two versions (one paid and one free); only the free version was reviewed, but paid features relevant to the research topic were obtained while using the application (free full version ranging from 3–7 days).[16] All extensions offered for in-app purchase were acquired to evaluate the full content provided.

The applications selected for inclusion were organized on an Excel spreadsheet with their characteristics, including information on the developer, installation number, content rating, and a brief summary of the content, in addition to the price and version of the application.

Application Quality Assessment

To ensure the highest possible performance in evaluating the applications, the operating system version of both cellphones

Table 1 Detailed sections of Mobile Application Rating Scale (MARS)

Section	Feature
Engagement	Entertainment, interest, personalization, interactivity, and target group suitability
Functionality	Performance, ease of use, navigation, and gestural design
Aesthetics	Layout, graphics, and visual appeal
Information	App description accuracy, objectives, quality of information, quantity of information, visual information, credibility, and evidence base
Subjective quality	Recommendation to others, app star ratings, usage, and whether users are willing to pay for the product

Source: adapted from Stoyanov et al. (2015, p.5).[9]

was updated with the latest option available. The MARS results were used to assess the products' quality. This scale has 23 items and is a simple, reliable tool for assessing the quality of applications. There are 5 sections: engagement (5 items), functionality (4 items), aesthetics (3 items), information quality (7 items), and subjective quality (4 items). A 5-point scale was used for each item: 1 - inadequate, 2 - bad, 3 - acceptable, 4 - good, and 5 - excellent.[9] ►**Table 1** displays a detailed description of the scale.

The subscales of engagement, functionality, aesthetics, and quality of information were used to calculate the mean and standard deviation (SD) of the app scores. To ensure objectivity in the quality assessment, subjective app quality items were not included, as this section is reported as optional.

The application must be based on evidence found in the scientific literature to answer the item "evidence base" in the information section. To assess this item, a search was performed in Medline/PubMed and Google Scholar databases with the name of the application as a keyword followed by the terms "app" or "mobile app" to identify related scientific publications.

The two primary reviewers were trained to employ MARS using the training material developed by the scale's authors.[9] Any items with unclear meaning were discussed between the reviewers. A pilot test was conducted for additional training and for checking consensus between the reviewers. A limit score of two points of difference between results was established and, in case of disagreement (difference greater than two points on any item of the MARS subscales), the item was discussed with a third reviewer to reach a consensus. For the pilot test, 10 free apps available at the App Store and Google Play Store were randomly selected and evaluated by both reviewers.

Data Analysis

A Microsoft Excel (Microsoft Corp., Redmond, WA) version 2019, spreadsheet was used to compile the data. Mean scores were first calculated from the results of each item of the MARS sections, engagement, functionality, aesthetics, and information quality. They were then added together to provide an overall mean and SD for the app's quality score. The next step was to determine the sum of the means and SDs for each MARS section and all incorporated apps.

Results

Among the 2,264 relevant mHealth apps identified, 11 were eligible for inclusion (►**Fig. 1**). Excluded apps were duplicates, not up-to-date, or not relevant to this research's purpose (apps with internal content in English). Among the 11 apps included in this study, 3 (27.3%) were found exclusively on the App Store, 4 (36.4%) were found exclusively on the Google Play Store, and 4 (36.4%) were found on both. All apps were free to download and only 2 did not offer in-app purchases. The selection process of the mHealth apps is shown in ►**Fig. 1**. The characteristics of those included are described in ►**Table 2**.

Commercial companies developed all 11 apps included in the present systematic review. *SnoreLab: Grave seu ronco* and *SnoreClock – Você ronca?* were tested and had partially positive results in scientific studies that were not randomized controlled clinical trials.[17–19] ►**Table 3** offers a more detailed description of the main objectives of the applications.

Quality Assessment (MARS)

The mean ± SD of the MARS results of the 11 apps was 3.5 ± 0.8 on a scale of 1 to 5. Most apps scored lower in terms of credibility. The mean score on the engagement subscale was 3.5 ± 0.7. The mean score on the functionality subscale was 4.2 ± 0.5, with most applications considered functional. Mean aesthetics subscale score was 3.7 ± 0.4, with some applications featuring attractive layouts and graphics with good resolution. Most apps did not provide scientific evidence found in the literature. However, some apps cited sources of verifiable legitimacy. The mean score assigned to the information subscale was 2.7 ± 1.5. There was agreement between both reviewers using this tool and differences between scores did not exceed the pre-established 2-points threshold. ►**Table 4** displays the quality assessment of the applications according to MARS.

Privacy Policy

Regarding the data privacy policy, only two apps (*SleepUp: Sleep well* and *Vigilantes do Sono*) have a data privacy policy in Portuguese and are in accordance with the General Data Protection Law (LGPD). One app (*PrimeNap: Free Sleep Tracker*) does not present any information on this matter.

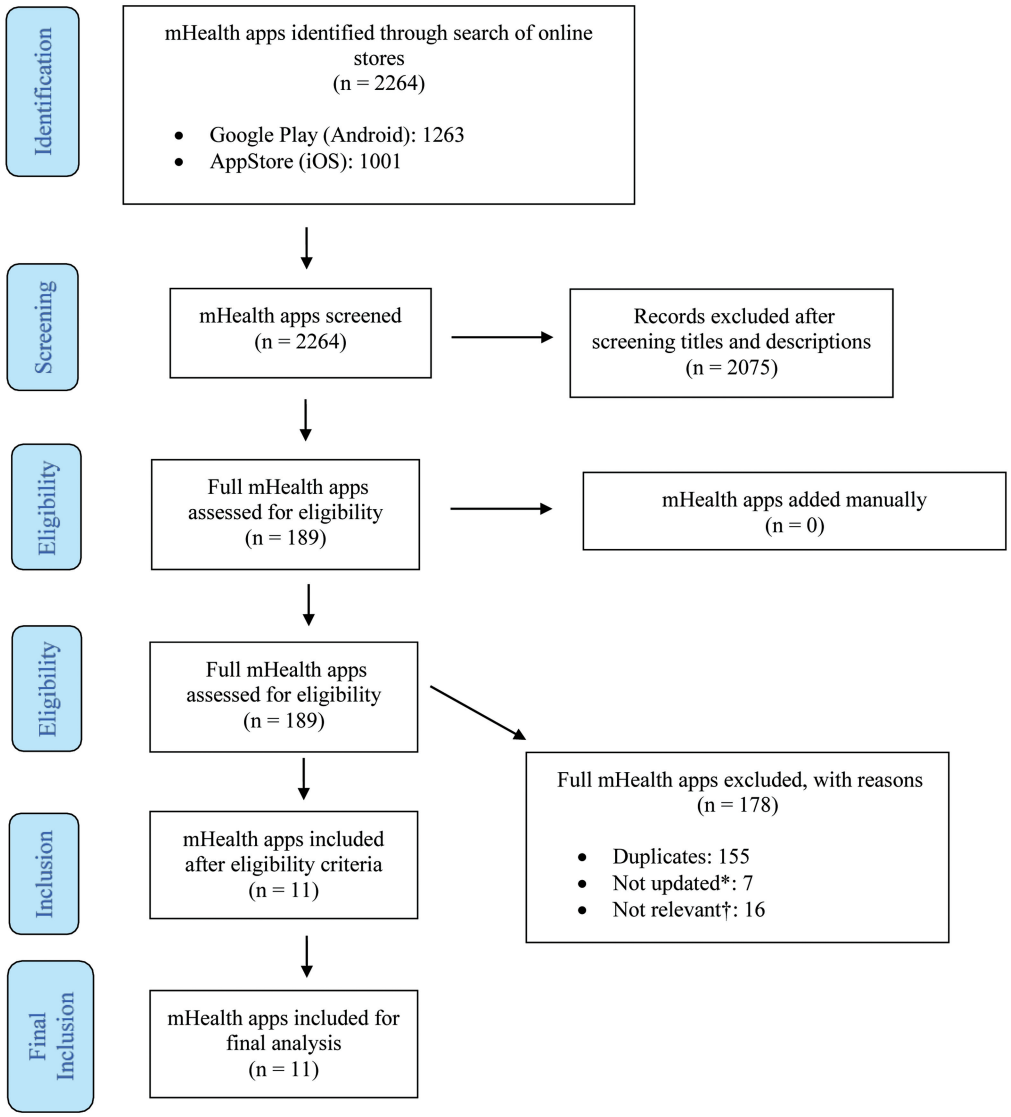

Fig. 1 Flow diagram for mobile health applications (mHealth apps) search results. *To ensure software functionality and ongoing technical support to users, only apps developed or updated between 2020 and 2022 were included. † One app was not found in the Google Play Store; one app was excluded due to a functionality error; seven apps were excluded because they did not fit the research's objective; seven apps were excluded because they were not in the search language.

One (*Google Fit: fitness tracker*) follows the privacy and security policy of the Google platform. Two apps (*Sleep Science Alarm Clock* and *SnoreClock Do you snore?*) explain data protection in their privacy policy. The other apps guarantee privacy and data protection in accordance with the General Data Protection Regulation (GDPR) and/or California Consumers Protection Act (CCPA) for the users residing in the countries where they were developed, which means they do not extend to Brazil.

Application Rating

The three highest scoring apps had mean overall app quality scores ranging from 4.1 to 4.3. Two apps (*SleepUp: Durma bem* and *Vigilantes do Sono*) provided social media components or interactive support groups for users. The three applications presented a good level of content and visual appeal. All were developed for commercial purposes. However, in addition to the team of sleep experts, *Sleep Up: Durma bem* is the first platform to improve sleep with clinically validated digital therapies approved by the Brazilian Health Surveillance Agency (Anvisa). The *Vigilantes do Sono* app is a startup accelerated by the Eretz.bio incubator at Albert Einstein Israelita Hospital and the *Google Fit: monitor fitness* app worked in collaboration with the world health organization (WHO) as well as the American heart association (AHA).

SleepUp: Durma Bem

This is a freemium application with the possibility of subscribing to two types of plans (standard or premium) available at the Google Play Store. The overall mean MARS score was 4.3. The standard plan offers the following: sleep diary and goals; lifestyle tips; music and guided meditations; daily, weekly and monthly reports; personalized guidance; four

Table 2 Description of mobile health applications for sleep time monitoring included in present review

Android					
App name	**Purpose**	**Price (R$)**	**Downloads***	**Developer**	**Affiliations**
Sleep as Android: Ciclo do sono	Sleep monitoring	Freemium R$9.99/month (Initial month R$2.99; First 7 days free) or R$25.99 (lifetime)	10.000.000+	Urbandroid (Petr Nálevka)	Commercial
PrimeNap: Free Sleep Tracker	Sleep monitoring	Free Remove ads: R$19.99	100.000+	Excelling Apps	Commercial
SnoreClock - Você ronca?	Sleep monitoring	Free Remove ads: R$13.99	1.000.000	Ralph Schiffhauer	Commercial
iOS					
App name	**Purpose**	**Price (R$)**	**Developer**		**Affiliations**
Despertador Ciência do Sono	Sleep time monitoring	Free	Phase4 Mobile		Commercial
Google Fit: monitor fitness	Sleep records	Free	Google LLC.		Commercial
Sleep Tracker Helper	Sleep time monitoring	Freemium R$30.90/week (First 3 days free); R$40.90/month; R$224.90/semester or R$249/year	Sergey Kolibaba		Commercial
Sleepzy - Relógio Despertador	Sleep monitoring	Freemium R$26.90/month; R$45.90/quarter or R$152.90/year (First 7 days free)	ThrivePort, LLC.		Commercial
Rastreador de sono & Alarme (Monitor de Sono)	Sleep monitoring	Freemium R$ 112.90/year (First 7 days free)	ABISHKKING Ltd.		Commercial
Vigilantes do Sono	Insomnia program, sleep logs and education	Freemium R$199.90/ year (First 7 days free)	Vigilantes do Sono		Commercial
SnoreLab: Grave seu ronco	Sound recording, sleep time monitoring and education	Freemium R$10.90/week; R$19.90/month (First 7 days free); R$32.90/quarter or R$58.90/year	SnoreLab Ltd.		Commercial
SleepUp: Durma bem	Sleep monitoring and education	Freemium Standard Plan R$24.99/month (First 7 days free) or R$149.99 (First 7 days free); Premium Plan R$69.99/month (First 7 days free) or R$399.99/year (First 7 days free)	SleepUp		Commercial

Table 3 Detailed description of main objectives of apps included in present review

App name	Store where it is available	Objectives
Despertador Ciência do Sono	App Store	Records sleep time using the smartphone's microphone and accelerometer. Uses the time setting in the alarm function and presents the results in graphs of data obtained during the week, month, and year.
Google Fit: monitor fitness	App Store Google Play Store	In addition to manual recording of sleep data (time user went to bed and woke up), it offers contents on general health, such as heart rate monitoring, menstrual period, weight, daily physical activity, food intake, and personal goals.
Sleep Tracker Helper	App Store	Presents daily and weekly sleep analysis by enabling the device's microphone and setting alarm times, offering the results in graphs and sound recording, pointing out the quality of sleep in percentages, in addition to proposing recommendations and challenges to help users sleep better.
Sleepzy – Relógio Despertador	App Store Google Play Store	Uses the device's internal microphone to analyze the sleep cycle and recognize sounds during sleep, also offering alarm, sleep records with a graph demonstrating sleep phases, sound resources, breathing exercises, and sleep trends based on nights of sleep recorded. It also provides a demographic comparison of the data, recordings, notes, and sleep goals.
Rastreador de Sono & Alarme	App Store Google Play Store	Uses the device's microphone to monitor and analyze sleep quality, offering the setting of bedtime and alarm time, in addition to helping users fall asleep with calming sounds, stretching exercises, which are demonstrated through interactive videos, and breathing methods. It also has daily statistics with the record of sleep time, phases, notes, and night noises.
Vigilantes do Sono	App Store Google Play Store	Provides a program for insomnia based on a step-by-step guide, an interactive chat with a virtual assistant, guiding and suggesting instructions and information on how to improve quality of sleep, in addition to manual recording of sleep time, monitoring using the smartphone's accelerometer, and synchronization of sleep-time data from the resources of the device itself.
SleepUp: Durma bem	App Store Google Play Store	Offers complete manual recording of sleep time and quality, as well as education and information on the subject through videos, written content, charts, guidelines, and resources for sleep monitoring.
SnoreLab: Grave seu ronco	App Store Google Play Store	Offer sleep recording, with a focus on monitoring snoring, in addition to graphs, patterns of noises, and accounting for hours of sleep.
SnoreClock – Você ronca?	Google Play Store	
Sleep as Android: Ciclo do sono	Google Play Store	Only offer the alarm function, sleep monitoring based on the start and wake time of the alarm, graphs, individual customizations of sleep data, and counts the hours of sleep using the device's accelerometer and microphone.
PrimeNap: Free Sleep Tracker	Google Play Store	

clinical trials; sleep hygiene module; relaxation and meditation module; learning about sleep module; mindfulness therapy; and telemedicine with sleep specialists with separate payment. The premium plan has the features of the standard plan and offers a complete therapeutic program of cognitive behavioral therapy for insomnia, nine clinical tests and access to sleep specialists via chat.

This application has a team of sleep specialists and is the first digital therapy platform clinically validated and approved by Anvisa to improve sleep. *Sleep Up: Durma bem* monitors sleep by manual recording or wearable technologies. The weak point of the app is that, if the user does not use wearable technologies, manual recording is necessary of the time that they went to bed, managed to sleep, woke up and got out of bed. The strong point is the variety of features provided to improve the user's sleep, increasing the likelihood of achieving the desired goal.

Vigilantes do Sono

This application's overall mean MARS score was 4.2. *Vigilantes do Sono* is a freemium application with the possibility of subscription available at the Google Play Store and App Store and seeks to improve sleep, insomnia, anxiety and depression through behavioral changes. The program is based on cognitive behavioral therapy for insomnia guided by an artificial intelligence (Sônia) and lasting approximately seven weeks. Sleep monitoring occurs with the smartphone facing down on the mattress and close to the pillow. There is no need to connect the charger to the device, but it is necessary to have a fully charged battery. The user needs

Table 4 Mobile app rating scale (MARS) scores of apps included in present review ($n = 11$)

App name	Version	*Engagement*	*Functionality*	*Aesthetics*	*Information*	*Overall quality score*
SleepUp: Durma bem	1.27.0	4.5	4.3	4.7	3.9	4.3 (0.9)
Vigilantes do Sono	5.12	4.5	4.8	4.0	3.6	4.2 (0.8)
Sleepzy – Relógio Despertador	3.44.2	4.1	4.6	4.3	3.4	4.1 (0.7)
Rastreador de Sono & Alarme	2.3.1	3.9	4.9	4.2	3.1	4.0 (0.7)
SnoreLab: Grave seu ronco	5.3.16	3.5	4.3	4.0	3.9	3.9 (0.7)
Google Fit: monitor fitness	1.70	3.4	4.4	3.7	3.0	3.6 (0.8)
Sleep Tracker Helper	1.1.8	3.4	4.8	4.2	2.1	3.6 (0.8)
Sleep as Android: Ciclo do sono	20221101	3.1	3.6	3.5	2.2	3.1 (0.8)
Despertador Ciência do Sono	3.2	2.9	3.9	3.2	1.9	3.0 (0.9)
SnoreClock – Você ronca?	5.2.7	2.1	3.9	3.2	2.1	2.8 (0.8)
PrimeNap: Free Sleep Tracker	1.1.4	2.6	2.8	2.3	1.1	2.2 (0.8)
Scores for all apps	–	3.5 (0.7)	4.2 (0.5)	3.7 (0.4)	2.7 (1.5)	3.5 (0.8)

Notes: Data are presented as mean and mean and standard deviation (SD). Score ranges from 1 (inadequate quality) to 5 (excellent quality). Total score based on mean of each subscale.

to start and end the monitoring and it is possible to keep a sleep diary.

The strength of the application is the daily, quick interaction with the digital coach Sônia as well as a sleep diary to monitor and direct the program. The user's responses are used to personalize the service with tools and tips according to the individual. The user learns concepts about insomnia, sleep tips, relaxation training and cognitive techniques with a scientific basis and a team of sleep specialists. The limitation of the application is that the content of the application is presented mostly in text format, which may discourage use.

Sleepzy – Relógio Despertador

This is a freemium subscription-based app available at the Google Play Store and App Store, having achieved an overall MARS score of 4.1. *Sleepzy – Relógio Despertador* is a sleep monitor in addition to being a smart alarm clock that seeks to wake the user better. The app also provides a bedtime ritual with breathing exercises before sleeping, classical music, and relaxing melodies.

Sleep recording occurs through the microphone or accelerometer with the smartphone close to the user. There is no need to put the smartphone on the bed, but the charger needs to be connected to the device, and the user needs to start and pause the sleep recording. The application performs a comparison of the quality and duration of the user's sleep with Brazilian and worldwide average values. The strengths of the application are that, in addition to analysis and a sleep diary, it also works as a snoring recorder. The weak point of this application is that one must subscribe to the premium version to listen to the recording.

Discussion

To the best of our knowledge, this is the first systematic search to evaluate mHealth technologies aimed at monitoring sleep time available at Brazilian online application stores. In this study, we highlight the need to develop new evidence-based products that can help monitor sleep time for Brazilian users. According to the findings, two of the applications (*SleepUp: Durma bem* and *Vigilantes do Sono*) satisfactorily met the objective of the study, obtaining higher MARS scores and offering resources, information, and language compatible with Brazilian users. A third one (*Sleepzy – Relógio Despertador*) scored well on the MARS, but was not completely adapted for Brazilian users, as its privacy policy and terms of use are described in English, and the contents and resources are too broad.

Most apps had low MARS scores due to poor evidence-based information (i.e., whether the app has been scientifically tested or not), aesthetics (screen settings and visual elements), and/or engagement (i.e., users' experience when interacting with elements of the application may not be attractive enough to keep their interest).

This study can be compared with another study performed in Jordan, in which the lowest scores among the 6 applications included were also attributed to engagement and information issues.[20] However, the average MARS quality score (3.3) was lower than that found in the present study, as the evaluation was focused on applications in English (nonofficial language) and without subscription fees, which are the two main barriers for populations in developing countries.

The characteristics users value the most can improve the usability and results of health data. According to Mendiola et al.,[21] to promote sustained use and positively influence the user, it is necessary for applications to have features such as general education (offering basic educational material on the topic, motivating user autonomy and knowledge), data export (enabling the patient-consumer to dialogue with a healthcare provider) and improved engagement (this can be guided by gamification, for example, which is based on points and levels to be achieved according to a pre-established health objective).

Most current sleep applications are not supported by scientific evidence, and few have been submitted to

validation studies using polysomnography (gold standard), having been developed for commercial purposes and, therefore, resulting in an exemption from medical liability.[22] Moreover, according to an American survey, consumers of mobile applications express concerns about their personal data; however, 91% of the population accepts the terms and conditions of the installation without even reading them.[23] Despite the existence of strict laws in the respective countries as well as proposals to protect users in relation to using and sharing their personal information, most apps may not comply with protection rules, as reported in a mHealth study conducted in Brazil,[13] and corroborated in the present study. Thus, for a better experience and greater security, it is important for these points to receive attention in the development of mHealth applications.

The MARS score[9] does not address aspects of privacy and security. These aspects of mHealth apps are critical to increasing acceptance and usage among patients and healthcare professionals. In Brazil, user privacy and security rely on the "General Data Protection Law." A total of 72% of the apps included in the present review did not provide terms of use or privacy policies to users. Thus, they did not comply with Brazilian data protection rules, posing a potential risk to the security of user data.

Despite the availability of mHealth apps for monitoring sleep time in Brazil, evidence regarding their effectiveness is limited. Only 2 of the 11 apps evaluated in the present review have been tested and demonstrated partially positive results in studies that were not randomized controlled clinical trials, being *Snorelab: Grave seu ronco*[17,18] and *SnoreClock - Você ronca?*[19] and the studies evaluated the accuracy of applications in detecting snoring.

Only the *SnoreLab: Grave seu ronco* application has been compared with polysomnography, with acceptable accuracy regarding the measurement of especially loud snoring.[17] These mHealth applications for monitoring sleep time are indicated for self-management of the user's sleep and do not replace medical examination,[24] as none of the 11 applications included in our analysis had their results compared with polysomnography in terms the number of sleep hours.

Although the 11 apps evaluated do not have such validation, evidence suggests that the accelerometers in smartphones can reliably assess sleep time when compared with actigraph accelerometers.[25,26] Thus, it is possible that smartphone technology offers opportunities to support sleep self-management through mHealth applications, while still being able to promote healthy sleep habits, awareness, and home monitoring accessible to users.[27]

All of the 11 apps were developed for commercial purposes. However, 3 (*SleepUp: Durma bem*, *Vigilantes do Sono*, and *Google Fit: monitor fitness*) had greater credibility in the assessment using MARS compared with the other apps. In addition to the team of sleep experts, *SleepUp: Durma bem* is the first platform to improve sleep with digital therapies clinically validated and approved by Anvisa. The *Vigilantes do Sono* app is a startup accelerated by the Eretz.bio incubator at the Albert Einstein Israelita Hospital and the Google Fit app worked in collaboration with WHO and AHA.

Strengths and Limitations

The strengths of our study include its systematic approach following established reporting guidelines,[11,28] and the applicability of methods that can be used by other researchers aiming to evaluate new applications or new versions of existing applications. Furthermore, MARS is a simple, objective, reliable tool developed to classify and evaluate mobile health applications,[9] with good to excellent reliability and high objectivity. This scale proved to be adequate for assessing the quality of the sleep applications.[29] Additionally, the researchers who evaluated the apps using MARS underwent structured training that resulted in high agreement between them, ranging from 80 to 100% on the different subitems.

A limitation of our study is related to the rapid changes in the application market, with the updating of existing applications and the launching of new ones. Our systematic search covered applications launched or updated until May 2022 and, therefore, did not include more recent updates or new apps released after the period. However, this aspect can be a strong point, since this is the first and most recent review in the period of its publication and, as such, the closest to the current situation of products related to monitoring sleep time available at online stores in Brazil.

Conclusion

There were 11 relevant mHealth apps eligible for inclusion in this review. The sleep monitoring apps currently available in Brazil are of moderate to good quality but have limited credibility. The use of mHealth technologies to monitor sleep time is a topic with considerable potential for future investigation but is a relatively new and underexplored topic. Additionally, we highlight the importance of collaborations between researchers, clinical professionals, patients, and developers for the creation of new mHealth applications focused on Brazilian users and their sleep monitoring demands.

The most advantageous applications identified in this study were *Sleep Up: Durma bem*, *Vigilantes do Sono*, and *Sleepzy – Relógio Despertador*. The first one offers a comprehensive educational content and diversity of resources, such as the possibility of consulting experts. The second provides good informational content and a variety of options to monitor sleep time, namely the synchronization of data from the device itself, manual completion, and the monitoring of hours through the accelerometer of the device, in addition to daily, rapid interaction with the virtual coach. Lastly, *Sleepzy – Relógio Despertador* shows comparative and global statistics in relation to the users' average.

Future studies should evaluate the quality of the 3 most advantageous apps with potential end-users. For such, the user version of the mobile application rating scale (uMARS) is recommended as an objective tool that provides a reliable measure of the quality of apps from the users' standpoint.[30]

Disclosures
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Conflict of Interests
The authors have no conflict of interests to declare.

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