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Development of an application for sleep hygiene in adults

Desenvolvimento de aplicativo para higiene do sono em adultos

Desarrollo de una aplicación para la higiene del sueño en adultos

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Abstract

Introduction: Different clinical conditions can affect the quantity and quality of sleep. Sleep hygiene measures directly affect the quality of sleep. They can be disseminated to the population by means of applications. **Objective:** To develop, evaluate and make available an application that approach sleep hygiene and that is able to generate changes and verify the occurrence of excessive daytime sleepiness. **Methodology:** The application "Somnum" was developed and 26 speech therapists certified in sleep by the Brazilian Sleep Association were invited to evaluate it using the Emory questionnaire and another questionnaire developed by the authors. Afterwards, 38 students used the application and answered before and after the use the Pittsburgh Sleep Quality Index and the Epworth Scale. **Results:** After its development, the app was evaluated by 4 speech therapists who contributed with their suggestions, and 38 university students participated by answering the questionnaires, 6 of them before and after the use of the application. In the Pittsburgh Sleep Quality Index, it was observed in the statistical analysis, comparing before and after using the application, improvement in sleep quality (p=0.04). In the Epworth questionnaire, it was verified in the situation after using the "Somnum" application, that there was not significant difference. **Conclusion**: After using the application, there was a possible improvement in sleep quality. There was occurrence of excessive daytime sleepiness.

Keywords: Speech, Language and Hearing Sciences; Sleep Hygiene; Sleepiness; Sleep Medicine Specialty

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Authors' contributions:
IG, LDL: study conceptualization; tabulation; data analysis and interpretation; writing.
GAPS: application development and review.
MPP, CCC: study conceptualization and design; article review; tabulation; data analysis and interpretation; final approval of the version for publication.

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Resumo

Introdução: Diferentes condições clínicas podem afetar a quantidade e a qualidade do sono. As medidas de higiene do sono interferem diretamente na qualidade deste. Elas podem ser propagadas à população por meio de aplicativos. **Objetivo:** Desenvolver, avaliar e disponibilizar um aplicativo que contemple as medidas de higiene do sono e que seja capaz de gerar mudança e verificar a ocorrência de sonolência diurna excessiva. **Metodologia:** O aplicativo "Somnum" foi desenvolvido e 26 fonoaudiólogos certificados em Sono pela Associação Brasileira do Sono foram convidados a avaliar usando o questionário Emory e outro questionário elaborado pelas autoras. Após, 38 estudantes usaram o aplicativo e responderam antes e depois do uso o Índice de Qualidade do Sono de Pittsburgh e a Escala de Epworth. **Resultados:** Após seu desenvolvimento, o aplicativo foi avaliado por 4 fonoaudiólogas que contribuíram com suas sugestões e 38 universitários participaram respondendo os questionários, sendo que 6 deles participaram antes e após o uso do aplicativo. Sobre o Índice de qualidade de sono de Pittsburgh, foi observado na análise estatística, comparando o antes e após o uso do aplicativo, melhora da qualidade de sono (p=0,04). No que se refere ao questionário Epworth, foi verificado na situação após o uso do aplicativo "Somnum", que não houve diferença significativa. **Conclusão**: Após o uso do aplicativo, verificou-se possível melhora na qualidade de sono. Houve ocorrência de sonolência diurna excessiva.

Palavras-chaves: Fonoaudiologia; Higiene do sono; Sonolência; Medicina do Sono

Resumen

Introducción: Diferentes condiciones clínicas pueden afectar a la cantidad y calidad del sueño. Las medidas de higiene del sueño afectan directamente a la calidad del mismo. Pueden propagarse a la población mediante aplicaciones. **Objetivo:** Desarrollar, evaluar y poner a disposición una aplicación que incluya medidas de higiene del sueño y que sea capaz de generar cambios y verificar la aparición de somnolencia diurna excesiva. **Metodología:** Se desarrolló la aplicación "Somnum" y se invitó a 26 fonoaudiólogos certificados en soeño por la Asociación Brasileña del Sonido a evaluarla utilizando el cuestionario Emory y otro cuestionario elaborado por los autores. Posteriormente, 38 estudiantes utilizaron la aplicación y respondieron antes y después del uso de la misma al Índice de Calidad del Sueño de Pittsburgh y a la Escala de Epworth. **Resultados:** Tras su desarrollo, la aplicación fue evaluada por 4 fonoaudiólogos que aportaron sus sugerencias y 38 estudiantes universitarios participaron respondiendo a los cuestionarios, 6 de ellos antes y después del uso de la aplicación. Sobre el Índice de Calidad del Sueño de Pittsburgh, se observó en el análisis estadístico, comparando antes y después del uso de la aplicación, mejoría en la calidad del sueño (p=0,04). Con respecto al cuestionario de Epworth, se verificó en la situación posterior al uso de la aplicación "Somnum", que no hubo diferencia significativa. **Conclusión:** Después de usar la aplicación, hubo uma posible mejora em la calidad del sueño. Hubo ocurrencia de somnolencia diurna excesiva.

Palabras clave: Fonoaudiología; Higiene del Sueño; Somnolencia; Medicina del Sueño

Introduction

Sleep brings benefits to physical and mental well-being and aids in brain maturation by establishing and consolidating relevant knowledge and memories[1,2,3]. It is an essential biological function regarding binocular vision, thermoregulation, energy conservation and restoration, and brain energy metabolism restoration. Sleep deprivation or irregularities can affect various areas, such as learning and physical, emotional, occupational, and social behavior. For instance, sleep deprivation affects the functioning of the left-side visual field, thus changing the person's visuospatial perception, which may cause traffic and work accidents[4]. The estimated accident and death rates due to sleepiness or fatigue range from 2% to 41%, with high financial and life costs[5].

Pain, medication use, and different clinical conditions are factors that may affect the quantity and quality of sleep. Various sleep behaviors at different ages are likewise unfavorable to quality sleep. Watching television in the bedroom has been associated with weight gain, short sleep, and poor diet[6]. Induced sleep deprivation is increasingly frequent, especially among university students that exchange a good night of rest for academic activities[7]. This aggravating circumstance is also seen in night-shift workers, such as security, policepersons, physicians, and nurses[8].

Excessive daytime sleep (EDS) is a symptom that may appear in sleep disorders such as narcolepsy, restless leg syndrome/periodic limb movement disorder, obstructive sleep apnea-hypopnea syndrome, and so forth[9,10]. Most EDS interventions include sleep hygiene measures, which directly affect sleep quality[11].

Sleep hygiene recommendations include using the bedroom only for sleep; waking up and going to sleep always at the same time to have a regulated sleep cycle; sleeping enough hours[12]; avoiding long naps; keeping the environment as comfortable as possible; and avoiding alcoholic beverages (which may affect the musculature during sleep)[11], foods rich in simple carbohydrates, stimulating beverages, and physical activities soon before going to sleep[13].

The technological revolution and its devices may be seen as a negative aspect (as they have a harmful effect on sleep) or a positive aspect (as they promote sleep hygiene measures). Smartphone and tablet users a recurrently estimated at 2 billion people[14]. The field of health has not only approached it as a positive aspect but also primarily invested in technology to assist patients[15]. The literature had recurrently reported application use to treat diseases[16,17,18].

Thus, telehealth guides strategies to promote health through information and communication technology[19], involving a larger number of people[20].

An extensive analysis of speech-language-hearing (SLH) applications available on the various platforms did not find any that addressed sleep hygiene measures. Applications such as Sleepy, Sleep Cycle, and Pillow are offered but are paid. Most applications on sleep offer functions such as sleep alarms, snore detection, and an alarm that wakes up the user in a light stage of sleep. Nevertheless, polysomnography is the only gold-standard examination to detect sleep breathing disorders[21].

Sleep hygiene measures must be made known to the population as a means of treating sleep disorders. Application use may reach a greater number of people because they are made available on smartphones, to which most people currently have access 24 hours a day[14].

This paper aimed to develop, assess, and make available an application that addresses adult sleep hygiene measures, capable of changing the user's quality of life, for example, by reducing sleepiness and verifying EDS in university students.

Materials and methods

Research data collection began after approval of the Human Research Ethics Committee, CAAE 3166 5020.1.0000.8093. The research included individuals who agreed to participate by signing an informed consent form.

The sample calculation, made in GPower 3.1 software, proposed the participation of 98 people in the research – 26 SLH therapists (TG), certified in sleep therapy by the Brazilian Sleep Association (ABS, in Portuguese), and 72 university students (SG). Therapists were initially invited via e-mail, whose addresses were available on the ABS official website, while university students were invited via WhatsApp school groups. Those who were interested in participating read the informed consent form and then, having agreed to participate, furnished information such as name, age, sex, university program, height, and weight.

The sleep hygiene application was developed based on up-to-date scientific literature and resource use among the population to verify its impact on the knowledge of practical concepts of sleep. The process was structured based on an instructional design approach, encompassing four phases: analysis and planning, modeling, implementation, and assessment[22].

1st Phase – Analysis and planning

This phase used the basic scientific literature on sleep hygiene, accessing the LILAC, SciELO, and PubMed interfaces.

The search was based on the following strategy:

1. Sleep Hygiene; 2. Telehealth; 3. SLH Sciences; 4. Sleep

2nd Phase – Modeling

A search was conducted on the Play store, App store, and Microsoft store platforms to find applications with SLH features. Altogether, 11 applications were found and assessed regarding their resources, availability in the various application stores, price, clear language, and layout. These aspects were used to develop the sleep hygiene measures application, named "SOMNUM".

After developing the database strategy and search, the application material was constructed, using 2010 Microsoft PowerPoint to visualize the content with graphical resources.

3rd Phase – Implementation

The content was made available in the application to instruct users and raise their awareness with an additional (or the only) tool in SLH therapy support. Hence, the resources are provided through accessible and updatable technology to which individuals are connected.

The name chosen for the application is "Somnum" (which means "sleep" in Latin) because it conveys the desired serenity for good sleep quality.

The application was developed in C# programming language, using the Unity development platform engine. It focused on Android devices, as the IOS operating system makes it difficult to install applications not available in the Apple store, which in turn would considerably increase the project cost and time from what had been originally planned. Users can send data and have access to all information. The application receives and formats the information, which the user is free to send or review, as they wish.

4th Phase – Assessment

For the technical assessment group (TG), researchers invited 26 SLH therapists certified in sleep therapy by ABS. They were free to use the application, with no minimum time of use for technical analysis. Their participation in the research likewise required their signature on an informed consent form.

They were invited to use the application and assess its content usability and relevance through two questionnaires. One of them, published in the literature, is the modified Emory (Health-Related Web Site Evaluation Form – Emory University, Rollins School of Public Health, 1998). It is a reliable and valid instrument that critically assesses the credibility of health-related websites. The questionnaire concludes with the following possible classifications:

> *"**Excellent***: It is an excellent source of health information. Consumers can easily access and understand the information provided in this stool. Do not hesitate to recommend it to your clients."
>
> *"**Adequate***: Even though it furnishes relevant information and can be browsed without greater difficulties, it may not be the best tool available. If it is not possible to use other sources, this tool will provide good information to your clients. You must be careful to discuss with your clients the information they found on this website and what other information is still necessary".
>
> *"**Poor***: It should not be recommended to your clients. The information's validity and reliability cannot be confirmed. All information on the website may not be accessible. Seek other tools to prevent false or partial information from being read."

TG also filled out a questionnaire developed by the authors to indicate whether the application approached essential sleep hygiene topics. They should also judge the density of content regarding each behavior as very satisfactory, satisfactory, average, unsatisfactory, or very unsatisfactory, according to the classification.

After the technical assessment, the application was revised and modified according to the suggestions to be made available to the university population (UG). These students filled out questionnaires in two moments, before and after using the application for 10 days.

UG filled out:

- Pittsburgh Sleep Quality Index (PSQI)[23]: a standardized questionnaire that assesses sleep quality and disturbances with 19 self-assessment questions. The scores of seven components add up to final scores classified as follows: 0-4 means a good sleep quality; 5-10, a poor sleep quality; and above 10, a likely sleep disorder, being indicated to seek professional help.
- Epworth Sleepiness Scale (ESS)[23]: a questionnaire that objectively assesses sleepiness complaints in eight situations, whose items are answered on a scale from 0 to 3. Final scores from 0 to 9 are considered normal, and from 10 to 24 indicate EDS.

All questionnaires were made available online through Google Forms and filled out by research participants. Their answers were sent via e-mail to the research group for future data analysis and to the lead researcher.

To analyze the questionnaire answers, the results were tabulated in an Excel spreadsheet and submitted for statistical analysis. Data before and after application use were compared with Student's paired t-test (for quantitative variables) and the Wilcoxon Rank test (for ordinal variables). The significance level was set at 5%. The program used was Jamovi, version 1.2.25.

Results

Concerning the application

The data screen is the initial one in the adult application, in which the user enters information such as name, age, sex, weight, height, and university program (Figure 1). The second screen has room where users can inform what time they went to sleep the previous night and what time they woke up; they can also inform whether they smoked, were physically active, had energetic beverages, or used technology such as television or smartphone during the night. On this screen, users could also schedule a reminder to go to sleep.

The indispensable part of the application is the tab with sleep hygiene suggestions (Chart 1) – every day, the application made a new suggestion to users for them to consider and put into practice. Another tab shows achievements that users unlock as they are applied, to increase their motivation and regular application use. The final tab presented a chart, constructed as the user entered data; it showed the average sleep hours, which users sent to the research.

Figure 1 shows the application screens where users can enter data (A). The second tab records the user's sleep habits – such as the time when they usually sleep and wake up and whether they had stimulating beverages, used technology (such as the smartphone), or were physically active during the night (B). They could also set alarms to remind them to go to sleep and receive sleep hygiene suggestions (C).

Figure 1. "SOMNUM" application screens, in which users can enter data, set alarms, and receive suggestions

Chart 1. Suggestions given in the application

Sleep only enough to feel rested. If you feel well after 8 hours of sleep, avoid sleeping more than 8 or 9 hours, even if you don't have any commitments on that day.
Avoid naps during the day when you're coping with insomnia or non-restorative sleep. When you're sleeping better, occasional naps are no problem at all.
Set a routine of waking up always at the same time, regardless of whether it is on the weekend or whether you had insomnia during the night. For example, if you set to wake up at 8 am, be careful to always wake up at this hour.
If you enjoy taking a nap in the afternoon, it should last 20 minutes. Analyze your case to check how much nap time is good for you.
Regular physical activity helps regulate the circadian rhythm. However, such exercises must be done long before sleep. Avoid doing exercises for 4 or fewer hours before going to bed, unless you don't notice it directly influences your sleep quality.
Even if you don't quite notice it, sleeping in noisy environments decreases sleep quality. Make sure the place where you sleep is not much noisy. If it is, you may consider buying earplugs.
If you are used to having dinner/supper, choose lighter meals before going to bed – this normally helps many people to sleep better. Check whether it makes any difference to you.
Taking a hot shower before sleeping is usually relaxing – check whether it helps you sleep better.
Check whether consuming any stimulating food or drink after 6 pm impairs your sleep. The most common ones are coffee, Coca-Cola, *guaraná*, *chimarrão*, and some teas.
Avoid doing stimulating activities 1 hour before going to bed (for example, watching action movies, or playing computer/online games). Melatonin, the sleep hormone, is excreted as light diminishes. Try to sleep in the dark and check whether that helps.
Preferably, use the bed only to sleep and have sexual activities (avoid working or watching TV in bed).
Keep the bedroom temperature comfortable to start and maintain sleep.
Find what type of person you are: Morning people would rather sleep and wake up earlier and perform better at the beginning of the day. Evening people adjust better to sleeping and waking up later, performing better in afternoon and night activities. Intermediate people adjust better to either schedule, as long as it is stable.

Before going to bed, do some relaxing activities (for example, doing breathing exercises, taking a hot shower, and reading a book). Find what relaxes you and establish a routine.
If you go to bed and don't sleep within 20 minutes, it is better to get up from bed. Sit on a bedroom chair or the living room couch, and do another activity until you feel drowsy again (you may read for some minutes, have some hot tea, etc.).
Avoid taking sleeping pills without a prescription.
Light exposure plays a crucial role in helping our body regulate sleep more healthily. If possible, spend some time outdoors in natural light. Even if the sun is not shining intensely, natural light still has positive effects on the circadian rhythm.
It may not seem critical to your sleep, but kindness and connection with people may reduce stress and its harmful effects on mood and sleep.
To update on sleep news, follow the social media of the Brazilian Sleep Association.

Professionals pilot assessment

Eight of the 26 invited SLH therapists agreed to participate in the assessment. The adult application was assessed by four ABS-certified SLH therapists; the other four evaluators were excluded because their devices had only the IOS operating system. The questionnaires were answered online.

The questionnaire on content density developed by the authors (Table 1) had diverging answers due to the time of application use for assessment. There was no minimum time of use; however, the application has 20 suggestions presented one a day. Therefore, if SLH therapists used it for less time, they would see fewer features, which influenced their assessment. Food was a topic with diverging assessments in the density questionnaire (Table 1); hence, the authors decided to include another three diet suggestions, as shown below.

- A study has proven that drinking cherry juice twice a day improves sleep, making you fall asleep faster [24].
- A recent study has demonstrated that eating 2 kiwis one hour before going to bed improves sleep – both the total sleep time and sleep efficiency [25].
- Avoid high-glycemic carbohydrates before going to bed because you may take longer to fall asleep because of them [26].

Table 1. Questionnaire on the application content density

	Very satisfactory	Satisfactory	Average	Unsatisfactory	Very unsatisfactory
Q1- Afternoon nap	1 (25%)	2 (50%)	1 (25%)	-	-
Q2 – Environment control	3 (75%)	1 (25%)	-	-	-
Q3 – Physical exercises	2 (50%)	2 (50%)	-	-	-
Q4 – Foods*	**1 (25%)**	**1 (25%)**	**1 (25%)**	**1 (25%)**	-
Q5 – Technology use	2 (50%)	2 (50%)	-	-	-
Q6 – Alcoholic beverages	2 (50%)	1 (25%)	1 (25%)	-	-
TOTAL	11	9	3	1	0

Caption: *topic that received various suggestions.

The application was also assessed with the modified health-related website assessment Emory form (Table 2). The application underwent changes after analyzing the answers to the Emory form. For instance, it included a link to a document in Google Drive with a tab providing references, names, and contact of its creators and developers, as well as the ABS social networks.

Table 2. Answers to the modified Emory questionnaire

	Agree	Disagree	Not applicable
Q1 – Purpose of the application: clear	3 (75%)	1 (25%)	-
Q2 – It does not appear to be an advertisement in disguise	3 (75%)	-	1 (25%)
Q3 - Impartial	3 (75%)	-	1 (25%)
Q4 – Approach other aspects of the issue	2 (50%)	1 (25%)	1 (25%)
Q5 – Approach all aspects of the issue	2 (50%)	2 (50%)	-
Q6 – Furnishes external links	1 (25%)	-	3 (75%)
Q7 – Information is correct, accurate	3 (75%)	-	1 (25%)
Q8 – Clearly documented sources*	2 (50%)	**1 (25%)**	**1 (25%)**
Q9 – Comply with HONcode principles	-	-	4 (100%)
Q10 – Sponsored by/associated with an institution	3 (75%)	-	1 (25%)
Q11 – Information on authors/editors clearly provided and indicated*	2 (50%)	**1 (25%)**	**1 (25%)**
Q12 – Contact information provided *	2 (50%)	1 (25%)	1 (25%)
Q13 – Date of application publication indicated	2 (50%)	1 (25%)	1 (25%)
Q14 – Application recently reviewed	3 (75%)	1 (25%)	-
Q15 – Target-public evidently indicated	3 (75%)	1 (25%)	-
Q16 – Appropriate level of information details	3 (75%)	-	1 (25%)
Q17 – Appropriate reading level	4 (100%)	-	-
Q18 – Appropriate technical terms	3 (75%)	-	1 (25%)
Q19 – Internal links facilitate browsing	3 (75%)	-	1 (25%)
Q20 – Information can be retrieved	2 (50%)	1 (25%)	1 (25%)
Q21 – Offers a search mechanism	3 (75%)	-	1 (25%)
Q22 - Offers some type of search mechanism	1 (25%)	3 (75%)	-
Q23 – Logically organized	2 (50%)	2 (50%)	-
Q24 – If it requires installing a program to visualize its pages, it provides the link to it	-	-	4 (100%)
Q25 – External links are relevant	1 (25%)	-	3 (75%)
Q26 – External links are functional	1 (25%)	1 (25%)	2 (50%)
Q27 – External links are updated	1 (25%)	-	3 (75%)
Q28 – External links are appropriate	1 (25%)	-	3 (75%)
Q29 – External links provide reliable information	1 (25%)	-	3 (75%)
Q30 – External links take to organizations/ institutions important to the target-public's knowledge*	1 (25%)	-	**3 (75%)**
Q31 – Graphics, figures, and artwork add to the applications' worth	4 (100%)	-	-
Q32 – Graphs and figures do not slow down the page	4 (100%)	-	-
Q33 – There is an option to display only text	-	-	4 (100%)
Q34 – Its usefulness does not decrease when the only-text option is used	-	-	4 (100%)
Q35 – There are options for people with disabilities	1 (25%)	-	3 (75%)
Q36 – If the audio and video in the application are not accessed, information is still complete	2 (50%)	-	2 (50%)

Caption: *Topics in bold led to changes in the application

Target-public assessment

Altogether, 38 people answered the informed consent form, PSQI (Table 3), and ESS (Table 4) before using the application. Six of them participated before and after using the application and answered the questionnaires in two moments. Therefore, there was a discrepancy in the number of initial and final participants in this research. Their profile was of 35 (92.1%) females and 3 (7.9%) males, whose ages ranged from 19 to 40 years, with a mean age of 23.1 years. All of them were health sciences students – 36 (94.9%) in the SLH Sciences, 1 (2.6%) in Pharmacy, and 1 (2.6%) in Occupational Therapy.

Table 3. Comparison of the Pittsburgh Sleep Quality Index before and after application use

Question		Never	Less than once a week	Once or twice a week	Three or more times a week	Every day	p
Taking more than 30 minutes to fall asleep:	Before (n=38)	7 (18.4%)	11 (28.9%)	8 (21.2%)	10 (26.3%)	2 (5.2%)	0.34
	After (n=6)	3 (50%)	1 (16.8%)	2 (33.2%)	-	-	
Waking up in the middle of the night or too early in the morning:	Before (n=38)	3 (7.8%)	9 (23.6%)	8 (21.2%)	16 (42.2%)	2 (5.2%)	0.20
	After (n=6)	-	4 (66.8%)	2 (33.2%)	-	-	
Getting up to go to the bathroom:	Before	12 (31.5%)	11 (29%)	8 (21.2%)	6 (15.7%)	1 (2.6%)	0.14
	After	3 (50%)	2 (33.2%)	1 (16.8%)	-	-	
Breathing difficulties:	Before	32 (84.2%)	3 (7.8%)	2 (5.4%)	1 (2.6%)	-	0.34
	After	3 (50%)	3 (50%)	-	-	-	
Coughing or snoring loudly:	Before	32 (84.2%)	2 (5.2%)	2 (5.2%)	1 (2.7%)	1 (2.7%)	1.00
	After	4 (66.8%)	1 (16.8%)	1 (16.8%)	-	-	
Feeling too cold	Before	15 (39.5%)	12 (31.6%)	9 (23.7%)	2 (5.2%)	-	0.57
	After	1 (16.8%)	2 (33.2%)	2 (33.2)	1 (16.8%)	-	
Feeling too hot	Before	17 (44.7%)	12 (31.6%)	7 (18.5%)	2 (5.2%)	-	1.00
	After	3 (50%)	3 (50%)	-	-	-	
Having bad dreams or nightmares	Before	11 (29%)	15 (39.5%)	8 (21%)	3 (7.8%)	1 (2.7%)	0.77
	After	-	4 (66.8%)	2 (33.2%)	-	-	
Feeling pain	Before	15 (39.5%)	8 (21%)	11 (29%)	4 (10.5%)	-	0.08
	After	3 (50%)	2 (33.2%)	1 (16.8%)	-	-	
Other reasons: If so. please describe	Before	Ansiedade- 3 (8%)	Dor- 2 (5.3%)	Hipoglicemia- 1 (2.6%)	Barulho- 2 (5.2%)	Outros- 30 (78.9%)	0.08
	After	1 (16.6%)	-	-	1 (16.6%)	4 (66.8%)	
Q7. Sleeping pills	Before	31 (81.5%)	4 (10.5%)	-	2 (5.4%)	1 (2.6%)	1.00
	After	5 (83.3%)	-	-	1 (16.7%)	-	
Q8. Did you have problems staying awake? How often?	Before	18 (47.3%)	11 (28.9%)	7 (18.4%)	2 (5.4%)	-	0.57
	After	3 (50%)	3 (50%)	-	-	-	
Q9. Did you feel unwell to do your activities?	Before	2 (5.2%) nenhuma	7 (18.5%) pequena	18 (47.3%) moderada	11 (29%) muita	-	0.37
	After	1 (16.6%)	3 (50%)	-	2 (33.4%)		
Q10. Sleep for you is:	Before	Prazer- 17 (44.7%)	Necessidade- 21 (55.3%)	-	-	-	0.34
		3 (50%)	3 (50%)	-	-	-	

		Sleep Quality			
		Mean±sd	Good	Poor	
PSQI Total (Classification)	Before total (n=38)	5.58±2.54	14 (36.84%)	24 (63.16%)	**0.04***
	Before (n=6)	6±2.53	2 (33.33%)	4 (66.67%)	
	After (n=6)	3.83±2.14	5 (83.33%)	1 (16.67%)	

Caption: Wilcoxon rank test used to compare PSQI questions; Paired t-test used for PSQI sum. considering p<0.05 (*)

The statistical analysis regarding PSQI scores before and after application use indicated an improvement in sleep quality (p = 0.04).

As for ESS (Table 4), there were no statistically significant changes after using the application "Somnum".

Table 4. Comparison of the Epworth Sleepiness Scale before and after application use.

SITUATION		Mean±sd	Classification	p
Sitting and reading	Before (n=38)	1.26±0.97		0.85
	After (n=6)	1.33±1.21		
Watching TV	Before	1.66±1.02		0.76
	After	1.5±1.05		
Sitting in a public place	Before	0.63±0.75		0.77
	After	0.83±0.75		
As a passenger in a train, car, or bus, riding for 1 hour non-stop	Before	1.87±1.01		0.09
	After	1.17±1.17		
Lying down to rest in the afternoon	Before	2.29±0.98		0.57
	After	2.17±0.75		
Sitting and talking to someone	Before	0.13±0.53		1.00
	After	0±0		
Sitting calmly after lunch	Before	1.29±1.01		0.14
	After	1.17±0.75		
Driving a car	Before	0.07±0.35		1.00
	After	0.17±0.41		
Total Epworth	Before (n=38)	9.21±4.31	EDS: 16 (42.11%)	0.06
	Before (n=6)	11.75±3.59	EDS: 4 (83.33%)	
	After (n=6)	8.33±4.50	EDS: 2 (33.33%)	

Caption: EDS – excessive daytime sleepiness (Epworth score up to 9 points); Wilcoxon rank test used to compare PSQI questions; Paired t-test for PSQI sum, considering $p < 0.05$ (*)

Discussion

EDS is a common symptom in people with a sleep disorder, and most EDS interventions include sleep hygiene measures, which directly affect sleep quality. As this type of treatment is not at all harmful, the general population needs to know them – to which this study contributed with the application "Somnum".

The SLH therapists' pilot assessment included three additional diet suggestions, approaching foods that must be avoided because they can impair sleep, as this aspect is part of sleep hygiene. The results of a study[26] showed that sleep latency increased in individuals that had had a meal rich in carbohydrates 1 hour before sleep – i.e., sleep onset took longer than in individuals who had had the same meal 4 hours earlier.

Another change after the assessment was the inclusion of references and the authors' and application developers' names. A study[27] points out the importance of making such information clear and available to users to make them confident of the knowledge presented in the application.

Most study participants in UG were females (92.1%), which may have happened because women are often more prone to seeking means of improving their health using the Internet[28].

The analysis of PSQI answers (Table 3) indicates that four participants' scores (66.67%) characterize poor sleep quality, thus requiring medical attention. A study on medical students showed that the sleep of 261 participants (62.6%) was classified as poor or very poor[29]. Another study[7] reported that 77.1% of participants tended to have a sleep quality that required medical attention and/or treatment. Health students commonly induce sleep deprivation to carry out academic activities that require much time; thus, they report impaired sleep quality or fewer sleep hours[(7)].

The mean PSQI classification before and after application use was as follows: before, with 38 participants: 5.58 (standard deviation 2.54); before, with six participants: 6 (standard deviation 2.53); after, with six 6 participants: 3.83 (standard deviation 2.14) (Table 3). Hence, the sleep quality improved after using the application ($p = 0.04$). A study[11] showed the benefits of treating sleep disorders by combining cognitive therapies, stimulus control and sleep hygiene to perceive and quantify greater gains.

In the present study, ESS results before application use with 38 participants showed that 16 (42.11%) of them were classified with EDS. This finding was similar to those of a study that reported EDS in 32.2% of participants (likewise university students) from Pelotas, Rio Grande do Sul[30].

In the same questionnaire, four (83.33%) of the six participants before application use were classified with EDS, whereas only two of them (33,33%) remained with this classification after application use. Health intervention applications must enable and promote behavioral changes[18].

The contribution of this study was to develop, assess, and make available an application that approached sleep hygiene measures in adults and could change its users' sleep quality. No study was found in the literature with such a scope, aiming to make sleep hygiene measures known among university students. Unlike other applications that only furnish data and alarms, the goals and alarms in "Somnum" were defined by the user, who decided what they were able to accomplish. Moreover, unlocked achievements motivated them to continue using the application.

The limitations of this study include university students' low adherence to the application use. Since the research was conducted during the COVID-19 pandemic and social isolation, it is believed that many students were saturated with the use of social media and recurrent online academic projects. Future studies on applications should associate various sleep therapies to obtain quantitative results and apply them, for instance, to professionals that usually have sleep deprivation.

Conclusion

The application "Somnum" was developed to make sleep hygiene measures known to a group of university students. It was developed and assessed by SLH therapists who contributed with suggestions regarding diet and the inclusion of the researchers' data. Sleep quality possibly improved after using "Somnum", which was one of the objectives of the study. Participants were found to have EDS, which is common among university students.

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