

MORAL DILEMMAS AND ETHICAL CONFLICTS RELATED TO MOBILE APPLICATIONS FOR SLEEP IMPROVEMENT

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ABSTRACT

The sleep disorders are a variety of conditions that affect sleep and they seem to be increasing considerably among the population. At the same time, technological solutions have recently appeared claiming to help improve the sleep quality. Due to its ubiquity and ease of use, mobile applications are among the most commonly used technological aids to improve sleep among their users.

The objective of this work is to analyze, under an ethical judgement, the literature review about reliability and validity of mobile applications focused on sleep disorders, the ethical conflicts generated and the ethical judgment of the users.

The methodology followed consisted, on the one hand, an on-line search to collect a set of mobile applications focused on improving sleep that were recommended by some medical, governmental or at least non-commercial association or agency. The search has been conducted including the key words "sleep mobile app". On the other hand, a search of scientific publications has been carried out in order to find objective evidence about the observable performance selected apps.

The results obtained include a total of 31 different apps available either on the Android and iOS operating systems. Among that set, only 7 of them are mentioned in some clinical study. It is a low number given the amount of applications available, the estimated number of active users and taking into account that kind of information is completely unknown for the digital stores' users.

INTRODUCTION

The sleep disorders are a variety of conditions that affect the sleep quality, timing or duration of the sleep. There are more than 100 specific sleep disorders and the most frequent are insomnia, apnea and restless legs syndrome (Sleep Foundation, 2020). In the last decade, the prevalence of these disorders seem to be increasing considerably among the population (Acquavella et al., 2020); but during the last year, marked by the covid-19 pandemic, sleep problems have been widely studied and all authors agree with the fact that they have increased. Hung and Zhao (2020) reported that the 18% of the Chinese population studied had a poor quality of sleep, Stanton et al. (2020) informed about 40,7% in Australia, and Martínez-Lezaun et al. (2020) found that the 70% of the Spanish university students had, during the lockdown, worse sleep quality.

At least one of those signs characterizes these disorders: trouble to fall asleep, difficulties to stay awake during the day, imbalances in the sleep schedule or unusual behaviors that disrupt sleep (Sleep Foundation, 2020). The sleep disorders have also several consequences as memory and concentration difficulties, appetite disturbances and difficulties to perform activities of daily living (Ram, Seirawan, Kumar and Clark, 2010).

In order to improve the sleep quality, the Society of Behavioral Sleep Medicine (Crew et al., 2020) recommend maintaining certain level of physical activity and keep the exposure to natural light, since the lack of it induce mood disorders, alter the energy levels, provokes appetite disturbances and changes the sleep routine (Wright et al., 2013).

On the other hand, technological solutions have recently appeared claiming to help improve health. In this way, the term e-health was defined at the beginning of the century as an emerging field, referring to health services, characterized by a technical development but also a commitment to improve health using communication technology (Eysenbach, 2001). Related with this term, the mobile Health (m-health) refers to “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices” (WHO, 2011).

The World Health Organization (WHO) mHealth Technical Evidence Review Group developed, in 2016, the “mHealth evidence reporting and assessment (mERA) checklist”, with the aim of improving the completeness of reporting of mobile health (mHealth) interventions (Agarwal et al., 2016).

The creation of this checklist is a starting point to try to standardize the interventions through these devices, and it certainly helps health professionals who use them, to define the content, the context and the technical features. However, this may not be enough, and before deciding to implement the use of this kind of technology, it would be useful to know if these mobile applications have or not have effect on health. Before implementing a new treatment for any health condition, it has been subjected to numerous studies that support its effectiveness and results. However, this is not widespread in terms of the use of mobile applications for health-related purposes, which raises ethical questions that are important to reflect on.

The objective of this work was to analyze, under an ethical judgement, the most recommended mobile applications focused on sleep disorders, and reflex on the ethical conflicts generated and the ethical judgment of the users.

METHODOLOGY

As the first step of this study, a search of the existing literature related to mobile applications with an effect on users' sleep was conducted. Since there is no validated scientific search method related to applications (Linares-del Rey et al., 2019) and there are a large number of applications; first, a search for mobile applications related to sleep was carried out in the main mobile application e-shops' for the main operating systems: Android (Google Play) and iOS (App Store) search engines. In parallel, a search was carried out in the main web search portals (Google and DuckDuckGo), including the keywords "sleep mobile app" and selecting only web contents belonging to some medical, governmental or at least non-commercial association or agency, both English and Spanish. Apps that are not intended to improve sleep quality (i.e., only measure sleep time/quality) were excluded.

Subsequently, a bibliographic search of published scientific articles focused on the design, development and validation of the mobile applications that are recommended by the web content of pages detailed above was carried out. This search was performed in the following databases: PudMed and Web of Science.

As a result, only mobile applications that, at the same time, comply with all three conditions:

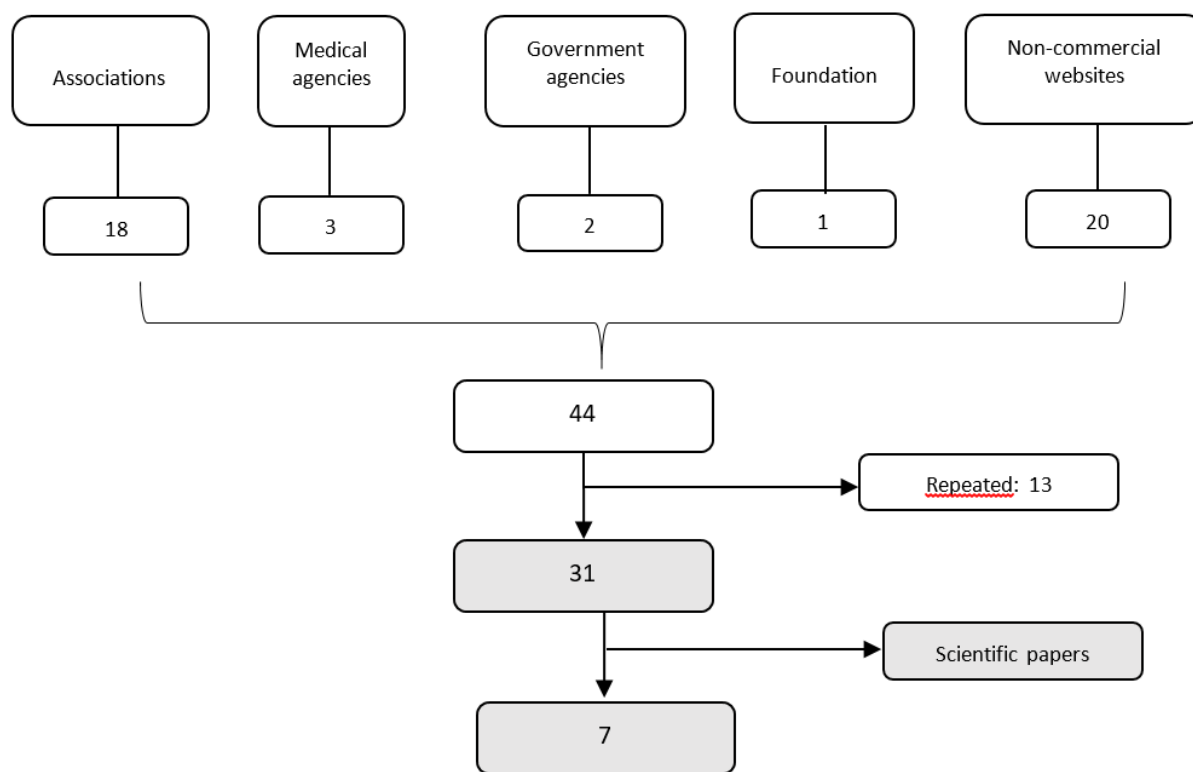
- a) claim to have some effect on users' sleep,
- b) are recommended by any content from non-commercial websites and

c) have been part of a scientific design, development or validation study were included in the study.

RESULTS

The present study included 31 mobile applications that were selected from 10 websites: four of which were websites of sleep-related associations, such as the American Sleep Association or the Indian Society for Sleep Research; three were non-commercial websites, two of which were medical agencies (Asociación Argentina de Medicina del Sueño, National Health Service); one government agency (US Department for Veteran Affairs) and one foundation (Sleep Foundation). After eliminating 13 repeated applications, a search was carried out in health science databases (PudMed and Web of Science), obtaining only 7 applications that had carried out a scientific study, whether validation, design or development (see Figure 1).

Figure 1. Sleep mobile apps search and selection process.



Source: self-elaboration

Regarding the 31 apps found (Table 1), most of them were available for Android and iOS devices (a total of 17 apps/ 54%), 6 only for Android devices (19,35%) 5 only for iOS devices (16,1%) and 3 for Android, iOS and Windows devices (9,3%) . The selected apps had been updated quite recently: in 2021 (15 apps/ 48.4%), 2020 (4 apps/13%) and 2019 (6 apps/19,3%). The resources the apps use to promote sleep were very varied, but the most used was the accompanying music (10 applications/32,2%), followed by white sound, understood as sound of rain, ocean, birds, rivers, among others (7 applications/22,5%) and meditation techniques (6 applications/19,3%).

4. Ethics of Emerging Technologies

The cost of the different applications is also very varied, only 7 are free, the rest have a cost ranging from 0.50 cents to 349.99 euros. In addition, some applications set the cost depending on the elements used by the user. Most of the applications are privately financed as only two applications are financed by governmental bodies. Regarding the number of downloads of the applications according to the download search engines, 2 applications reached 10 million downloads (6,5%); 4 reached 5 million (13%); 2 reached one million (6,5%); 3 reached five hundred thousand (9,3%); 5 reached one hundred thousand (16,1%) and 9 reached ten thousand (29%).

As can be seen in Figure 1, of the 31 applications found, only 7 have been described in scientific articles published in health science databases (PudMed and Web of Science); either as a result of a validation, design or development study which represents only the 22,5% of the selected apps.

Table 1. Descriptive data of the mobile sleep apps included in the study.

App Name	Last update	Resources	Price	Downloads	Ratings
Relax & Rest Guided Meditations App ^{a, e}	2019	Meditation	2,09€	10.000+	484 ratings; 4,5/5
Make You Sleepy ^{a, e}	2019	Accompanying music	Free	10.000+	36 ratings; 2,5/5
Sleep well ^{b, e}	2020	Hypnosis	3,09€	10.000+	2.521 ratings; 4,5/5
White noise ^{b, g}	2021	White noise	1,09€	10.000+	16.820 ratings; 4,7/5
CBT-i Coach ^{b, e}	2019	Cognitive behavioural therapy	Free	10.000+	153 ratings; 3,8/5
Insomnia Coach ^{b, e}	2019	Tips, Sleep journal	Free	5.000+	16 ratings; 3,5/5
My oasis ^{d, e}	2021	Accompanying music	0,50€-50,00€	5.000.000+	706.709 ratings; 4,6/5
Juego fácil de dormir ^{c, i}	2020	Accompanying music	Free	50.000+	296 ratings; 1,9/5
Sweet Dreams ^{c, e}	2018	Sheep counting with relaxing music	1,19€	10000+	274 ratings; 3/5
Calm ^{b, f}	2021	Meditation; Sleep stories; Relaxing music	0,77€-349,99€	10.000.000+	359.668 ratings; 4/5
Headspace ^{b, f}	2021	Meditation	6,99€-129,99€	10.000.000+	207.344 ratings; 4,6/5
Ten Percent Happier ^{b, e}	2021	Video and Meditation	4,99€-104,99€	500.000+	13.215 ratings; 4,8/5
MyLife Meditation: Meditate, Relax & Sleep Better ^{b, e}	2021	Meditation	9,99€-269,99€	1.000.000+	24.673 ratings; 4,6/5
Buddhify ^{b, e}	2021	Meditation	4,09€	100.000+	3.284 ratings; 3,9/5
Relax & Sleep ^{c, e}	2017	White noise	1,99€	5.000.000+	38.626 ratings; 3,8/5
Sleep Bug ^{a, e}	2015	White noise	1,99€	100.000+	1.576 ratings; 4,3/5
TaoMix 2: Sleep Sounds & Focus ^{b, f}	2021	White noise	0,99€-6,49€	100.000+	3.168 ratings; 4,6/5
Insight Timer ^{b, h}	2021	Music; Stories; Meditation;	2€-60€	5.000.000+	110.340 ratings; 5/5
Relaxing Music: Sleep Sounds ^{b, h}	2021	Accompanying music	2€-40€	1.000.000+	14.976 ratings; 4/5
Relaxing Music to Sleep ^{c, i}	2020	Accompanying music	Free	100.000+	4.706 ratings; 4/5
Relax Melodies ^{b, h}	2021	Accompanying music	19€ a 60€	10.000.000+	30.5192 ratings; 4,5/5
White Noise Generator ^{b, g}	2021	White noise	Free	1.000.000+	58.555 ratings; 4,3/5
myNoise ^{b, e}	2019	White noise	1€-12€	100.000+	2.554 ratings; 4/5
Awoken - Lucid Dreaming Tool ^{c, e}	2018	Guided Conversations	0,99€-6,49€	500.000 +	No data available
Sleep Cycle-Smart Alarm Clock ^{b, e}	2021	Sleep journal	0,89€-64,99 €	5.000.000+	130.073 ratings; 4,7/5
Relax Melodies ^{b, h}	2021	Accompanying music	2,99€-329,99€	10.000.000+	305.270 ratings; 4,6/5
Sleep Cycle-Power Nap ^{d, e}	2014	White noise; sound landscapes	2\$	No data available	657 ratings; 4/5

Pzizz-Sleep, Nap, Focus ^{d, e}	2018	High Frequency Sounds	10\$-70\$	No data available	83 ratings; 4,7/5
White Noise Lite ^{d, g}	2021	Hypnosis	Free	No data available	128.700 ratings; 4,8/5
Relax&Sleep Well-Hypnosis and Meditation ^{c, e}	2020	Meditation	1,19€-12,99€	500.000+	9.180 ratings; 4,7/5
Sleepio ^{d, e}	2021	Cognitive behavioural therapy	Free	No data available	87 ratings; 2,6/5

Operating Systems: ^a: android-*IOS*-Windows; ^b: android-*IOS*; ^c: android; ^d: *IOS*

Languages: ^e: English; ^f: English-Spanish; ^g: English-Spanish-French; ^h: English-Spanish-Other; ⁱ: Spanish

Source: self-elaboration

Table 2 shows the main characteristics of those apps that were included in any scientific publication. Two of them have been recommended by two different information sources, that is, non-commercial organizations; and most of them have been developed without any specific targeted population in mind. Financing of the implementation and exploitation is private for all, except CBT i-Coach, which is financed by a governmental agency. In total, the 7 applications have been included in 24 scientific publications; but 3 of them account for the 66.66% of the published reported results: Calm (6 publications), Headspace (5 publications) and CBT i-Coach (5 publications).

Table 2.

App Name	Web	Participants	Developers	Studies
Relax & Rest Guided Meditations App	Consumer Reports	ned	Meditation Oasis.	2
CBT-i Coach	Sleep Foundation Indian Society for Sleep Research	Insomniac patients	US department of veteran's affairs	5
Calm	Bestmattresses.com Sleepstation	Undefined	Calm.com Inc.	6
Headspace	American Sleep Association Prevention.com	Undefined	Headspace Inc.	5
MyLife Meditation: Meditate, Relax & Sleep Better	Consumer Reports	Undefined	Stop, Breathe & Think	3
Insight Timer	Prevention.com	Undefined	Insight Network Inc	1
Sleepio	National Health Service	Adults	Big health ltd	2

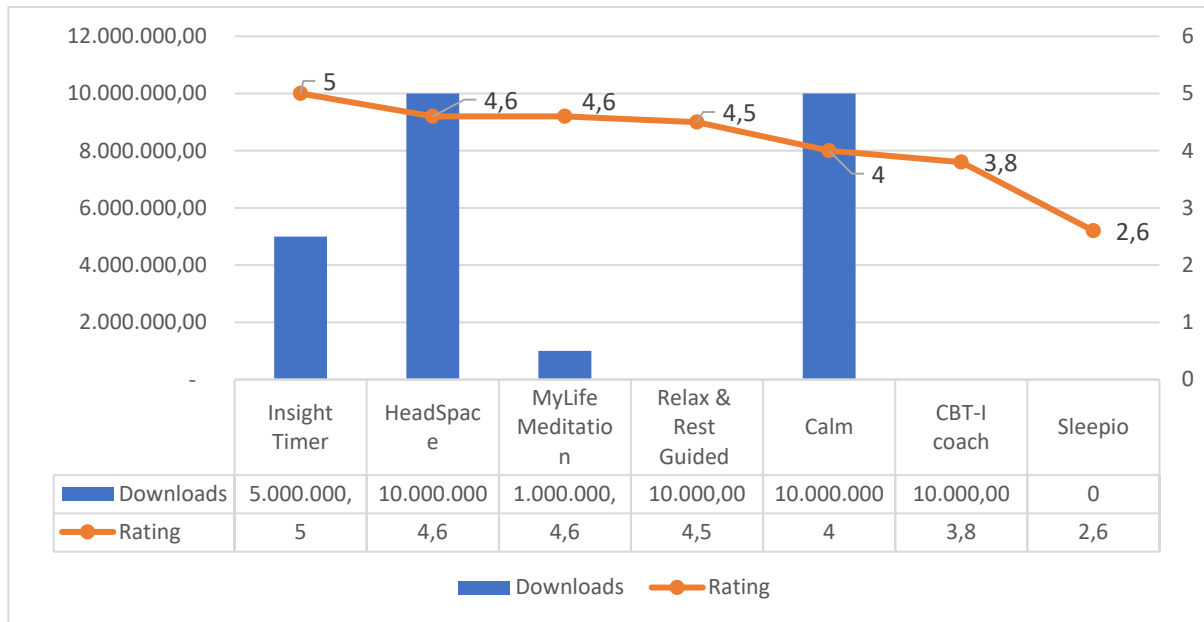
Source: self-elaboration

Figure 2 shows the data obtained publicly from the different on-line stores where they are officially available for their download and use, for the 7 mentioned apps. Regarding the number of downloads and average rating, it can be observed that 4 applications have an average rating between 5 and 4,5 points, while the number of downloads is higher than 10 million for the 2 most popular apps and that 4 out of 7 have reached a number of downloads of 1 million or more.

All data has been collected from the Google Play Store. Since the Sleepio app is only available on the Apple Store, authors don't have access to that information, since it is not publicly included in this platform.

4. Ethics of Emerging Technologies

Figure 2. Seven apps that are included in scientific research, comparing number of downloads and average user rating for each one.



Source: self-elaboration

DISCUSSION AND CONCLUSIONS

Europe has gone into the digital market twenty years ago; during this time, technological improvements have gone noiseless growing up, and, carving up a new knowledgeable generation. Furthermore, TIC's mean a new way of speaking, a new language, new symbols and meaning, new tones and icons, and, consequently, some lacks right understanding about the rules and values of managing. This implies mistakes and controversies, moral dilemmas and statements about the right or wrong use of this trending usability of TIC's and the behavior caused through its usability.

One of the most disruptive App's, what is, Serious Games, are used by the population (youngest specifically) with a natural and innate talent, and, this is because they manage more quantity of data, information, knowledge and contents immediately, and, because the digital market offers a huge range of possibilities. As consequence, this new products paradigm force to analyze and value controversial parameters, such as, ethics, security and privacy.

This research –as a reflex on the ethical conflicts generated in the usability of serious games for improving sleep quality- reports a vague relationship between the vast list of technological applications developed and the rigorous scientific validation procedure. Despite what we might expect, just a mere 22% out of the total amount of applications can be potentially distinguish in scientific nomenclature (clinic validation). The underlying point is that TIC's community should reflect the results of the Apps sorting. Research efforts should also focus on mainly ethics, security and privacy. Ethics, because is mandatory to research about the conflicts within the validation of the licenses; security and privacy because in the Big Data virtual world is compulsory to respect rules and regulations and guarantee products and services' know-how.

Taking into consideration another dimension of the use of technologies, what are the users themselves, it is mandatory to opened up some questions regarding their ethical judgment such as perceive risk of use (Khaled and Faqih, 2016; Littler and Melanthiou, 2006; Wiegard and Breitner, 2017), behavioral intention (Balakrishnan and Griffiths, 2018; Lee, Chung and Lee, 2013), sustainable

consumption (Mulcahy, Russell-Bennett and Iacobucci, 2020) and performance expectancy (Orji, Mandryk and Vassileva, 2017).

A key contribution is the connection with the behavioral intention of use. The number of downloads generates a feeling of adherence; potential users perceive more interest and security and the product aim to become more and more attractive. Findings point out that a mere 22.5% of the Apps have carried out some type of research study. Specifically, up to 24 research studies reinforce these Apps in their objective of improving the quality of sleep with their usability parameters. In addition, of these, more than half have 10,000,000 downloads.

The average valuation is very high, which means that there is a market very receptive to this type of products to improve rest; even those applications with hardly any downloads have some kind of medium-high positive rating. It can be inferred that the reason for this high assessment lies in the importance and need that is given to the quality of sleep, considering that there are more and more stimuli that hinder good rest.

The study carried out also shows that it would be very interesting for each App to get the most specific general rating based on the parameters on which its research studies are based (rest time, etc.) including publications with an impact index that endorse the improvements obtained. In parallel, comments on the usability and results of the tools that are publicly exposed are also part of the instrumental value of the product. The approach in this sense cannot be merely economic, neither self-interests, it must also be ethical and based on core values (real information, legal and social policies, rational and impartial).

Based on other collected monitored data, App's review ratings related to emotional perceptions - influencing aspects such as behavioral intent and performance experience-, therefore, moral discourse in this regard should be retrieved. In this sense, outcomes suggest the importance of embedding context with real track data set by dismissing those that do not serve for the App's purpose rather than confuse.

When commenting on the criticism from sustainable consumption, the research does not bring new light on the issue. The ordinary discourse focused on the real taxonomy of the concept implies a responsible acquisition, responding to basic needs and optimizing quality of life. Findings point out that while in most of the Apps analyzed there is no specific target population neither premises, the use and benefits of the applications on improving sleep quality cannot be compared. So, in short, the products are susceptible of being severely hindered, because, on the one side, the users are unable to distinguish which App provides assistance in their sleeping troubles and, on the other hand, Apps turn into profoundly impersonal.

Regarding the concept of security in ICT, it is positively valued that the Apps shows a privacy policy notice. It has been verified that the rigor of security and privacy is detailed in the collection of data provided by the users, other data on the use of services (data of use, data of operations, data of registry, data of device, information generated, cookies, data from other sources), use of data, data communication, advertising and analytical services provided by others, transfer of personal data, account data, promotional communications, alerts and other notifications, legal basis, data retention and requests of the interested parties. Finally, it should be noted that it cannot be concluded that the evaluations are better or worse depending on whether the Apps is within a scientific study compared to the Apps that are not. Overall, the current research study recognizes that, under moral considerations, Serious Games -as trending digital products in the store-, are potentially debatable in terms of ethical conflicts generated by the App as a technological resource, and ethical judgment of the users. In this sense, discussion derived from the literature review, point out the opportunity for these new innovative products to primarily work together, offer data security and data protection.

Technology products developed for healthcare in daily routines (quality of sleeping specifically) need to be launch in the market by testing acceptance, perceived advantages, privacy risk, limitations and benefits. A big challenge issue for the industry that build-in trusting products to reinforce its usability and feasibility.

KEYWORDS: App, Serious Games, Sleep Disorders, Ethics and Morality, Sustainable Consumption.

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