Sleep Disorders in Portugal Based on Questionnaires

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Abstract. Sleep disorders are a public safety concern that can influence the individual's quality of life by reducing cognitive functions, decreasing alertness, causing mood disturbances and exhaustion, and affecting memory. The evaluation of daytime sleepiness, the risk of developing sleep apnea, sleep quality, and the respective circadian rhythm are important aspects to consider. This research aimed to evaluate sleep disorders, in the Portuguese population, districts, since it is still a gap in the literature. 2087 complete answers were collected, with most of the participants being female, and their ages ranging from 18 to 78 years old. In terms of sleep disorders, 21.37% of the participants have a high risk of developing obstructive sleep apnea, 39.29% have excessive daytime sleepiness, and 61.38% have bad sleep quality. For the circadian rhythm, 57.74% of them are morning type, 36.85% are evening type, and the remaining 5.41% are intermediate type. In this research, it was proved that few elements of the Portuguese population are aware of their sleep quality, and most of the people with excessive daytime sleepiness have bad sleep quality. In addition, it was also demonstrated that the work schedule is adjusted to the circadian rhythm, and the risk of sleep apnea in participants with excessive daytime sleepiness is about 1.8 times higher than in the ones with normal daytime sleepiness. This study is innovative since it integrates four questionnaires on sleep disorders, considers a representative sample from the Portuguese population, and has the largest number of participants when compared with the studies available.

Keywords: sleep disorders · Pittsburgh · morningness-eveningness · Epworth · STOP-Bang · Portugal · questionnaire

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1 Introduction

Sleep disorders damage one's health, mood, and quality of life, which also affects sleep duration, the incidence of cardiovascular disease, diabetes, and respiratory problems [1,2]. Different epidemiological surveys [3,4] proved that a patient with the following diseases has disturbed sleep: allergic rhinitis, sleep apnea, asthma, or obstructive pulmonary disease. Furthermore, it was also found in [5] a positive association between insomnia and diabetes, obesity, hypertension, congestive heart failure, anxiety, or depression. This means that it is critical to understand how mental and physical health can influence sleep duration and quality [3]. According to [6], sleep is a critical indicator of our health and should be regarded as an essential component of a healthy lifestyle. Furthermore, it has been demonstrated that sleep disorders worsen with age [7]. Poor sleep quality has an impact on individual performance since it affects working memory, processing speed, and cognitive throughput. It is regarded as a major public safety concern since it can increase work accidents, and sometimes people are not aware of their sleep problems [7,8].

Several studies were carried out to determine the prevalence of sleep disorders in the Portuguese population. Some of them intended to understand the impact of sleepiness while driving and the respective consequences [9,10]. There are also studies to analyze the general sleep quality of the Portuguese population [11,12]. In 2014 [9] a study assessed excessive daytime sleepiness and sleep apnea risk among Portuguese truck drivers. Participant recruitment was achieved via e-mail sent to commercial truck companies operating from the north and center of Portugal. From a total of 714 drivers, 20% of them had excessive daytime sleepiness, and 29% had a risk of developing obstructive sleep apnea. A different approach was developed in [10], in which the sample size selection (900 drivers) was chosen using stratified sampling while taking into account the number of driver's licenses in Portugal. The phone numbers of the participants were chosen at random, and they had to be regular drivers, that is, they had to drive vehicles at least once a week. According to the results achieved, 35.30% of the drivers had bad sleep quality, 9.11% had excessive daytime sleepiness, and 10% had a risk of developing sleep apnea. In 2018 [11] the sleep quality of 1119 Portuguese adults was assessed, without identifying how the sample size was achieved. Some participants (28.2%) reported sleep disorders, and 54.8% had poor sleep quality. According to the sleep difficulties index, the majority of the participants have some sleep problems, which are likely to increase with age. Moreover, 62.9% of adults sleep between 6 and 8 h during the week, whereas 44% only need 1 to 15 min to fall asleep. As early as 2020 [12], new information was added about the previous study. Thus, 51.4% of adults reported difficulty falling asleep, 80.5% woke up during the night, and 75.3% awoke spontaneously.

Therefore, there is still a gap, in the literature, on sleep disorders in the Portuguese population, using a representative sample that considers the various districts of Portugal, taking into account the territorial distribution of NUTS II in Portugal. This comprises seven divisions, or regions, five of which are located on the mainland and the remaining two being the autonomous regions of the

Azores and Madeira's territories. For that reason, this research aims to evaluate different sleep disorders, in the adult Portuguese population, using a representative sample. Hence, it is intended to evaluate sleep quality, daytime sleepiness, the risk of obstructive sleep apnea, and circadian rhythm. With this study, it is expected to answer the following questions:

1. The Portuguese population is aware of their sleep quality?
2. Is it true that people with excessive daytime sleepiness have bad sleep quality?
3. The circadian rhythm is adjusted with the work schedule? If not, does it influence their sleep quality and daytime sleepiness?
4. Is it true that people with a risk of developing sleep apnea also have excessive daytime sleepiness?

This article is structured as follows. Section 2 presents a literature review, where the available questionnaires are presented to evaluate daytime sleepiness, developing obstructive sleep apnea, sleep quality, and circadian rhythm. The questionnaire's format, the duration of its availability, the software that was utilized, and the methodology used to determine the representative sample are all described in Sect. 3. The statistical analysis is described in Sect. 4, and the discussion of the results is in Sect. 5. Finally, the main conclusions are reported in Sect. 6.

2 Literature Review

This section will introduce daytime sleepiness, the risk of developing obstructive sleep apnea, sleep quality, and circadian rhythm. Firstly, a brief introduction of each theme will be brought in, and then an identification of different questionnaires available in the literature will be presented.

2.1 Daytime Sleepiness

Daytime sleepiness can affect individual health, which leads to serious consequences, like the risk of motor vehicle accidents and work-related incidents. This means that the individual's cognitive functions are reduced, by affecting their ability to gain or maintain employment. The main causes of daytime sleepiness are sleep deprivation, medication effects, illicit substance use, and obstructive sleep apnea [13].

Thus, the Epworth Sleepiness Scale (ESS) [14] is widely used to measure daytime sleepiness. There are eight questions based on different situations, where the subject has to rate on a scale of 0 to 3 how likely they are to fall asleep, considering their recent routine. So, the final score can be between 0 and 24. If the final score is greater than 10, the subject has excessive daytime sleepiness. The Portuguese version is available at [15].

Sleep-Wake Activity Inventory (SWAI) [16] also evaluates excessive daytime sleepiness, considering six components like excessive daytime sleepiness, distress,

social desirability, energy level, ability to relax, and nighttime sleep. This questionnaire is composed of fifty-nine items that are answered on a Likert scale from 1 to 9 which means the behavior is always present, or it never occurs, respectively. The respondents must answer questions regarding their habits only during the last seven days, where lower scores indicate more daytime sleepiness. There is no validation for this questionnaire in Portuguese.

2.2 Developing Obstructive Sleep Apnea

Obstructive sleep apnea is considered a sleep disorder and is defined by episodes of partial or complete upper airway obstruction during sleep [17]. This disorder has several adverse effects, such as excessive daytime sleepiness (the main symptom), decreased alertness, and, in turn, greater difficulty concentrating, and mood disturbances [18].

Therefore, STOP-Bang questionnaire [19] is applied to identify the risk of developing obstructive sleep apnea. This one considers snoring, tiredness, observed apnea, high blood pressure, body mass index, age, neck circumference, and male gender. Thus, there are eight dichotomous questions, and the final score is between 0 and 8. Those with scores equal to or greater than 5 have a high risk of developing moderate to severe obstructive sleep apnea. The Portuguese validation version of the STOP-Bang can be found in [20].

Berlin Questionnaire [21] is another alternative to evaluate the risk of developing sleep apnea. It considers snoring behavior, wake-time sleepiness or fatigue, and the presence of obesity or hypertension. There is also information about the participant's age, weight, height, sex, neck circumference, and ethnicity. This questionnaire is divided into three sections: snoring and apnea (five questions), daytime sleepiness (four questions), and hypertension or obesity (one question). The identification of a high or low risk for developing sleep apnea is based on the responses in each category. If two or more categories have a positive score, then the participant has a high risk, otherwise, the participant is not at risk. The Berlin validation version in Portuguese can be seen in [22].

Quebec Sleep Questionnaire [23] is also used for obstructive sleep apnea, with 32 questions. This questionnaire is divided into five domains, hypersomnolence, diurnal symptoms, nocturnal symptoms, emotions, and social interactions. Each question is scored on a 1 to 7-point Likert scale. The final result is achieved by computing the mean score (1 to 7) within each domain and summing the results. Smaller scores represent a higher impact on the participant's life due to sleep apnea. The Portuguese validation of this questionnaire is available in [24].

2.3 Sleep Quality

Sleep quality is commonly used in the medical field, where it is needed to evaluate different sleep metrics such as total sleep time, sleep onset latency, fragmentation, total wake time, sleep efficiency, and sleep disruptive events [25]. Poor sleep quality can have an impact on an individual's mood, attention, memory, and exhaustion [26].

Mini Sleep Quality (MSQ) [27] evaluates both insomnia and excessive daytime sleepiness, considering 10 questions. It takes into consideration a seven-point Likert scale ranging from never (1) to always (7). In terms of final classification, it's possible to define the participants as having good sleep quality (total sum of scores between 10 and 24), mild sleep difficulties (25 to 27), moderate sleep qualities (28 to 30), and severe sleep difficulties (over 31). There is only a Brazilian Portuguese version of the MSQ questionnaire [28].

Pittsburgh Sleep Quality Index (PSQI) [29] is commonly used, to assess the previous month's sleep quality. This one has 19 questions that are divided into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. Each component has a score of 0 to 3 and, the final score (0 to 21) is the sum of the scores of each component. The subjects with a final score over 5 have bad sleep quality. The PSQI questionnaire validation in Portuguese can be found in [30].

Sleep Quality Scale (SQS) [31] is another questionnaire to measure sleep quality, also about the previous month. In terms of structure, it is composed of 28 items that are divided into six factors: daytime dysfunction, restoration after sleep, difficulty falling asleep, difficulty getting up, satisfaction with sleep, and difficulty maintaining sleep. A four-point Likert scale was used, with scores ranging from 0 (few) to 3 (almost always), with higher scores indicating poor sleep quality. For this questionnaire, there is no Portuguese validation version.

2.4 Circadian Rhythm

The circadian rhythm, our twenty-four-hour rhythm, is another aspect to analyze when sleepiness is being studied since it is possible to identify when the subject wants to be awake or to asleep. For example, a morning person has a preference to get up early in the morning and go to bed early at night. Evening people, on the other hand, have a preference for going to bed later and, consequently, waking up later than a morning person [32]. When the circadian rhythm is not adjusted to the person's living, it has negative consequences on the resting cycles and physiological and behavioral functions of the individual. Thus, sleep disorders can be caused due to work schedules that are not in accordance with the circadian rhythm [33].

The Morningness-Eveningness questionnaire, developed by Horne and Ostberg [34], consists of 19 questions, and the final score is between 16 and 86. The subjects with classifications between 16 and 30 are a definitely evening type, 31 to 41 moderately evening type, 42 to 58 neither type, 59 to 69 moderately morning type and 70 to 86 definitely morning type. Since the previous questionnaire is very extensive, five questions were extracted to identify the circadian rhythm. This study aimed to reduce the time and effort of the researchers and participants [35]. In 2002 [36], a Portuguese adaptation version was developed and the number of questions was reduced to 16, and the time scales were changed.

Recently, in 2016 [37], an improved scale to measure the circadian rhythm was developed to improve the limitations of the Horne and Ostberg question-

naire. It was intended to improve the four and five Likert scales, eliminate self-assessment questions, add at least two dimensions, one for morningness and the other for eveningness, and reduce the number of questions. Thus, the questionnaire developed has 15 questions using a Likert scale of one to five points. Furthermore, it allows identifying three factors, separately, like distinctness, morning and eveningness affect. Note that the factor distinctness is used to identify if the participant has strong changes in performance and mood, during the day. Each factor has five questions, where higher values represent more changes during the day, morning, and evening preference. This questionnaire is known as Morningness-Eveningness-Stability-Scale improved (MESSi) and the Portuguese version is available in [38].

3 Procedure

Firstly, it was necessary to decide which questionnaires would be used in order to evaluate daytime sleepiness, the risk of developing obstructive sleep apnea, sleep quality, and circadian rhythm. The questionnaires were chosen based on the advice of a sleep physician, and their availability in Portuguese, who recommended using the following: ESS, STOP-Bang, PSQI, and MESSi.

Thereby, the next step was the construction of the final questionnaire to assess sleep disorders. The LimeSurvey platform was used, and it was divided into five parts. The first one is about personal information, such as sex, age, weight, height, geographic distribution, profession, driving questions, work schedule, and weekly hours. The driving questions were the following ones.

3.1: Do you have a driver's license? Yes or no.
3.2: Do you usually drive? Yes or no.
3.3: What type of vehicle do you usually drive? Light passenger car, light goods vehicle, or other.
3.4: What type of course do you usually take? Long or short distance.
3.5: How many years do you have a driver's license? 0 to 5 years, or more than 5 years.
3.6: In the last year, have you ever driven with drowsiness that forced you to stop? Yes or no.
3.7: In the last year, have you ever fallen asleep at the wheel? Yes or no.
3.8: In the last year, have you ever come close to having a traffic accident because you fell asleep at the wheel? Yes or no.
3.9: In the last year, have you had any traffic accidents because you fell asleep at the wheel? Yes or no.
3.10: In the last year, have you had any car accidents for any other reason? Yes or no.

The remaining parts were related to the sleep disorders questionnaires (ESS, STOP-Bang, PSQI, and MESSi), in the Portuguese version.

The third step was the definition of the target audience and the determination of the sample size, in order to be representative of the Portuguese population.

Thereby, it was decided to focus on the adult population, by region, since getting answers about infants, children, and adolescents would be difficult. Portugal's regions are divided into the North, Center, Lisbon Metropolitan Area, Alentejo, Algarve, Autonomous Region of Azores, and Madeira according to the NUTS II classification system. Stratified sampling was applied to determine the representative sample, by region, for the Portuguese adult population. This type of stratification uses probabilities, and the population is divided into different strata, which are exclusive and homogeneous segments, where the next step is the definition of a simple random sample for each stratum, known as a stratum. Moreover, from the proportion of the stratum in the population, the size of the stratum, in the sample, is determined. This approach is known as proportionate stratified sampling [39].

In order to identify the sample size, by region, a confidence interval for the population proportion was considered, which can be expressed like Eq. 1, and the estimation error is given by Eq. 2. It is important to understand all the parameters used, so $\hat{p}_i$ is the estimated proportion, $z_{\left(1-\frac{\alpha}{2}\right)}$ is the chosen z-value, also known as the critical value for the standard Normal distribution, α the level of significance, and n_i the sample size to being identified [40].

$$\hat{p}_i \pm z_{\left(1-\frac{\alpha}{2}\right)} \times \sqrt{\frac{\hat{p}_i \times (1-\hat{p}_i)}{n_i}} \tag{1}$$

$$\text{Estimation Error} = z_{\left(1-\frac{\alpha}{2}\right)} \times \sqrt{\frac{\hat{p}_i \times (1-\hat{p}_i)}{n_i}} \tag{2}$$

After defining the level of significance (α), and the estimation error, the sample size, by region, can be computed as in Eq. 3.

$$n_i = \left(\frac{z_{\left(1-\frac{\alpha}{2}\right)} \times \sqrt{\hat{p}_i \times (1-\hat{p}_i)}}{\text{Estimation Error}} \right)^2 \tag{3}$$

In this research, it was opted to consider both the level of significance and the estimation error as 5%, which means the final expression can be computed as in Eq. 4.

$$n_i = \left(\frac{z_{\left(1-\frac{0.05}{2}\right)} \times \sqrt{\hat{p}_i \times (1-\hat{p}_i)}}{0.05} \right)^2 = \left(\frac{1.96 \times \sqrt{\hat{p}_i \times (1-\hat{p}_i)}}{0.05} \right)^2 \tag{4}$$

According to the National Institute of Statistics of Portugal[1], in 2020, it was identified almost 8.6 million adults, in Portugal. After identifying the number of adults by region, the proportion was computed by dividing the number of adults in each region and the total number of Portuguese adults. Thereby, the northern region has the highest number of adults, followed by the Lisbon Metropolitan Area and the Center. The number of adults (N_P), in Portugal, by region, the respective proportion (P), and the minimum value of the representative sample size (N_S) to be achieved are given in Table 1.

Table 1. Adult Population by region and respective proportion.

Region	N_P	P	N_S
North	3012972	35%	350
Center	1898999	22%	264
Lisbon Metropolitan Area	2323345	27%	303
Alentejo	592869	7%	99
Algarve	358763	4%	61
Autonomous Region of Azores	197084	2%	34
Autonomous Region of Madeira	212533	2%	37
Total	8596565	100	1149

Finally, it was time to collect the answers. The sleep disorder questionnaire for the Portuguese adult population was made available on December 3rd, 2021, and it was closed one year later. In terms of dissemination, social networks such as Facebook and LinkedIn, as well as e-mail contact with companies, universities, and town halls in various districts, were considered.

After one year of disclosure, two lines had to be eliminated after analyzing the responses, since the participants answered all the questions with the same number. Then, some of the values in the height, time to bed, and time to be awake features had to be corrected. For example, some participants, instead of inputting 130 cm in height, introduced 1.30. Besides that, the hours to go to bed or wake up also had inconsistencies, instead of 23:00 it was only introduced 23.

For the classification of sleep disorders, the instructions from the STOP-Bang, ESS, and PSQI were considered, however, in the MESSi the questionnaire is only divided into three factors (distinctness, morning affect, and eveningness) and higher values represent more changes during the day, morning and evening preferences, respectively. Therefore, if the morning factor was greater than the evening one, the circadian rhythm was set as the morning type. If the evening factor was greater than the morning factor, it was considered an evening type. Otherwise, it was set as an intermediate circadian rhythm type.

[1] Available in https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0007307&contexto=bd&selTab=tab2, accessed: 2021-10-26.

4 Statistical Analysis

In this section, the sample description is detailed, where the number of responses achieved by the regions of Portugal and personal information are presented. Then, the sleep disorders analysis was conducted to answer all the research questions with the appropriate methods. McNemar and proportion tests were implemented to evaluate two dependent and independent categorical features, respectively. The independence and strength of the association between two categorical features were assessed using the χ^2 test and odds ratio. The results displayed were computed using the Python software (version 3.8.5), considering the `pandas`, `matplotlib`, `seaborn`, `statsmodels`, and `scipy` libraries.

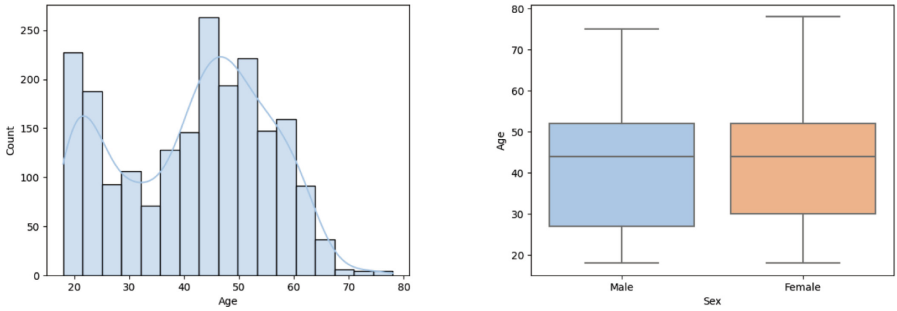
4.1 Sample Description

In terms of responses, values well above what was initially set as a minimum value were achieved, with 2089 complete answers. The results are presented in Table 2, and it is possible to identify that the North, Lisbon Metropolitan area, and Center have more responses than the other regions, followed by the Azores, Madeira, Alentejo, and Algarve.

Table 2. Sample Stratification by Region.

Region	*N*
North	468
Center	338
Lisbon Metropolitan Area	455
Alentejo	159
Algarve	97
Autonomous Region of Azores	297
Autonomous Region of Madeira	273
Total	2087

From the achieved results, 73.93% were female, where 34.49% had normal weight, 28.94% were overweight, 20.36% were at risk of being overweight, 13.90% were obese, and the remaining 2.31% were underweight. In terms of age, the median value is equal to 44 years old, which means 50% of the participants are younger than 44 years old. The minimum and maximum values were 18 and 78 years old, respectively. Figure 1a presents the age distribution, where it is visible that most of the participants are young (between 18 and 29 years old) and middle age (40 to 60 years old). Using the age by sex, Fig. 1b, it is perceptive that the ages are similar between males and females, even though there are more females in the study.



(a) Age Distribution. (b) Age by Sex.

Fig. 1. Participants Age.

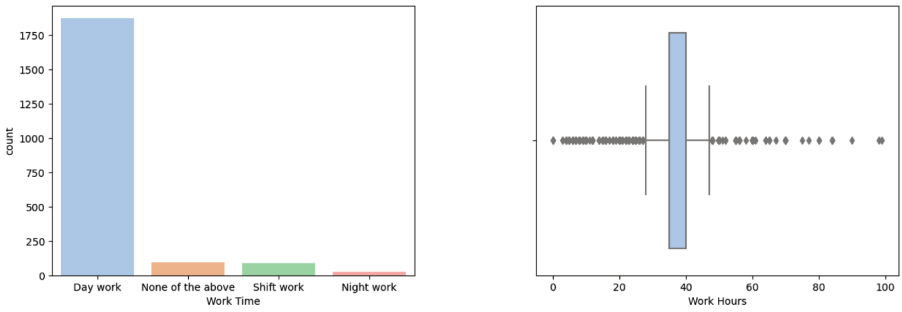
Table 3 presents the answers achieved about driving. Therefore, most of the participants have a driving license (91.57%), usually drive (92.26%) light passenger cars (95.41%), short course routes (77.82%), and 88.60% have more than 5 years of driving license. Moreover, a few of the participants were forced to stop the car due to drowsiness (12.37%), in the last year, where 2.21% fell asleep at the wheel. Of those who fell asleep, 74.36% were close to having a traffic accident, and 20.69% had actually a traffic accident due to drowsiness. Conversely, of those who have a driver's license and usually drive, only 6.07% have had an accident for any reason other than drowsiness at the wheel.

Table 3. Answers about driving.

Question	Options	Values	Question	Options	Values
3.1	Yes No	91.57% 8.43%	3.6	Yes No	12.37% 87.63%
3.2	Yes No	92.26% 7.74%	3.7	Yes No	2.21% 97.79%
3.3	Light passenger car Light goods vehicle Other	95.41% 2.95% 1.64%	3.8	Yes No	74.36% 25.64%
3.4	Short Course Long Course	77.82% 22.19%	3.9	Yes No	20.69% 79.31%
3.5	0 to 5 years More than 5 years	11.40% 88.60%	3.10	Yes No	6.07% 93.93%

Another piece of information collected was about the work schedule and the respective duration, Fig. 2. It is perceptible that most of the participants work during the day (89.70%), 4.36% shift work, only 1.29% during the night, and 4.65% do not fit into the previous options. In terms of work duration, per week, most of the participants work between 35 and 40 h. These are the durations for the public and private sectors, respectively. Although three students defined the

work duration as zero, others' values of less than 35 h, per week, may be of those who work part-time. There are also participants (25%) that work more than 40 h, per week.



(a) Work Time. (b) Work Hour.

Fig. 2. Work Information.

In terms of sleep disorders, the results achieved are presented in Table 4. Using the STOP-Bang questionnaire, 21.37% of the participants have a high risk of developing obstructive sleep apnea. Furthermore, 29.29% have excessive daytime sleepiness, and 61.38% have bad sleep quality. With the PSQI questionnaire, it was identified that most of the participants (50%) normally get 6 to 8 h of sleep, per night. Besides that, 50% of them need 10 to 30 min to fall asleep. For the circadian rhythm, 57.74% have morning preferences, 36.85% have evening preferences, and the ones that do not have morning or evening preferences can be considered intermediate or neither type. Regarding the distinctness effect, the first quartile (Q_1) was equal to 14, the second (Q_2) to 17, and the third (Q_3) to 19. In other words, 25% of the participants have a distinctness affect less than 14, 50% of them between 14 and 17, and the remaining 25% have values higher than 19.

Table 4. Sleep Disorders Results.

Questionnaire	Options	Values
STOP-Bang	Low Risk	78.63%
	High Risk	21.37%
ESS	Normal	60.71%
	Excessive	39.29%
PSQI	Bad Quality	61.38%
	Good Quality	38.62%
MESSi	Morning Type	57.74%
	Evening Type	36.85%
	Intermediate	5.41%

4.2 Sleep Disorders Analysis

The Portuguese Population is Aware of Their Sleep Quality? Two aspects must be considered for this research question: subjective sleep quality (SSQ), as reported by each participant in the PSQI questionnaire, and the PSQI final result. All the participants had to identify their sleep quality, divided into four levels: very good, fairly good, fairly bad, and very bad. For this analysis, the options "very good" and "good" were aggregated and defined as good sleep quality. The same approach was applied to the remaining options that were considered to have bad sleep quality. Thereby, the statistical hypotheses to be tested were defined 5, where π_1 is the proportion of subjective sleep quality and π_2 is the proportion of Pittsburg Sleep Quality.

$$H_0 : \pi_1 = \pi_2 \text{ vs } H_1 : \pi_1 \neq \pi_2 \tag{5}$$

The appropriate method to answer the research question is the McNemar Test [41], which is used for two dependent categorical features, with two classes each (2×2). The statistic test (χ^2) was equal to 457, and the p-value was less than 0.001. Considering the level of significance of 5%, the proportion of subjective sleep quality and the Pittsburg Sleep Quality are different. After this conclusion, it is important to understand whether the participants are aware that their quality of sleep is good or bad. Table 5 presents the contingency table between the SSQ and PSQI final results, where it is visible that 532 participants defined their sleep quality as good, however, it is bad. Therefore, some parts of the Portuguese population are not aware of their sleep quality.

Table 5. Contingency Table of Pittsburgh by SSQ for the 1st Research Question.

SSQ	Pittsburgh		
	Bad	Good	Total
Bad	749	26	775
Good	532	780	1312
Total	1281	806	2087

Is it True that People with Excessive Daytime Sleepiness Have Bad Sleep Quality? For this research question, the ESS and the PSQI final results are the features to be analyzed since they identify who has normal or excessive daytime sleepiness, and good or bad sleep quality, respectively. Firstly, it is necessary to select all the participants with excessive daytime sleepiness, and then evaluate the proportions of good and bad sleep quality. In the null hypothesis, the proportions are considered equal, that is, there are no differences in the sleep quality of the participants with excessive daytime sleepiness. Thus, a proportion test for two independent samples was performed, where $z = 17.38$, and the $p - value < 0.001$. Thus, there are differences between the proportions of good

and bad sleep quality among those who have excessive daytime sleepiness. In terms of proportional values, 71.46% of the participants with excessive daytime sleepiness have bad sleep quality, and the rest of the participants (28.54%) have a good quality of sleep. Thereby, the research question was proved, so people with excessive daytime sleepiness indeed have bad sleep quality.

The Circadian Rhythm is Adjusted with the Work Schedule? If Not, Does it Influence Their Sleep Quality and Daytime Sleepiness? For this research question, the MESSi final result (morning, evening type, or intermediate) and the work time (day, night, shift work, or none of the above) were considered. It is intended to test if the circadian rhythm and work time features are independent of each other. The appropriate test for this research question is the χ^2 test, where the null hypothesis is about the independence of the features under study. Therefore, the results achieved were $\chi^2(6) = 33.80$, and $p - value < 0.001$. Thus, there is a significant association between work time and circadian rhythm. Using the visualization in Fig. 3, it is clear that individuals who are considered to be morning type (green color) are more prevalent in daytime work, and those who are evening type (blue color) are associated with night work. For the shift work, the proportions are balanced between morning and evening types. Therefore, the work schedule is adjusted to the circadian rhythm.

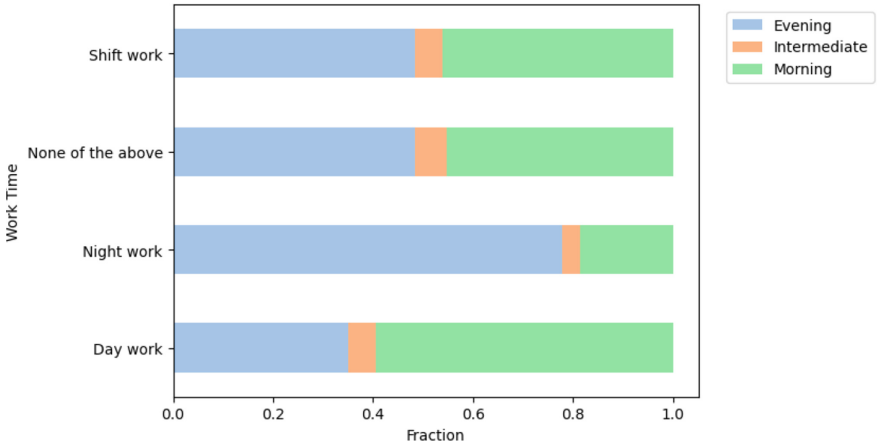


Fig. 3. Circadian Rhythm by Work Time.

Is it True that People with a Risk of Developing Sleep Apnea Also Have Excessive Daytime Sleepiness? To answer the present research question, the comparison between STOP-Bang and ESS final results was the main goal of the analysis. Aside from that, it was decided to evaluate the odds ratio between the two features in order to determine the strength of the association.

The odds ratio achieved was equal to 1.79, indicating that the possibility of detecting a high risk of sleep apnea with excessive daytime sleepiness is about 1.8 times higher when compared with the group that presents normal daytime sleepiness. The 95% confidence interval was equal to]1.44; 2.21[and since the unit does not belong to the interval, there is a significant association between the apnea risk and excessive daytime sleepiness.

5 Discussion

There was an increase in individuals with excessive daytime sleepiness (39.29%) in this study when compared to the results in [9,10], which achieved 20% and 9.11%, respectively. On the other hand, the study developed in 2014 [9] had a high risk of developing obstructive sleep apnea for 29% of the participants, and in 2015 [10] only 10% of the participants had a high risk. However, in our study, it was achieved 21.37%. In terms of sleep quality, there are values of 35.30% [10] and 54.8% [11] of bad sleep quality. In our study, the number of individuals with bad sleep quality was higher (61.38%). It is also possible to compare the values of the sleep duration and the respective time to fall asleep. According to [11] 62.9% of adults sleep between 6 and 8 h, per night, and 44% of adults need 1 to 15 min to fall asleep. In our analysis, it was identified that 50% of adults sleep 6 to 8 h, and it takes 10 to 30 min to fall asleep. Although, 48.78% of adults fell asleep for less than 15 min. Most of the results achieved are higher than the ones presented in other studies, however, it is important to understand that the sample numbers differ and were extracted in different ways. What can impact the results. It is also important to be aware that the responses are subjective since they will depend on how the person understands the question.

According to [8] people are not aware of their sleep deficiency and the effects of sleep deprivation. For that reason, the hypothesis about the Portuguese population was investigated, and it was verified that 41.53% of the adult participants were unaware of their bad sleep quality. Thus, it is essential to identify strategies to address this problem so that people can find reliable solutions to their sleep problems. Furthermore, excessive daytime sleepiness is a consequence of bad sleep quality [42], and when this was evaluated, it was possible to conclude that 71.46% of the adult participants with excessive daytime sleepiness actually have bad sleep quality. Which is in line with the literature. Sleep disorders can also occur when work schedules are not aligned with the circadian rhythm, according to the literature [33]. For the Portuguese adults, in the study, it was proven that the work schedule is adjusted to the circadian rhythm. Another aspect available in the literature is that excessive daytime sleepiness is the main symptom of obstructive sleep apnea [18]. Using the odds ratio, it was possible to conclude that people with excessive daytime sleepiness have a 1.8 times higher risk of developing obstructive sleep apnea than people with normal daytime sleepiness.

6 Conclusions

Sleep disorders are a concerning topic since they can influence an individual's health, mood, and, at the same time, quality of life. For that reason, there are several questionnaires available to evaluate different sleep disorders, such as daytime sleepiness, the risk of developing obstructive sleep apnea, sleep quality, and the type of circadian rhythm. Sleep disorder questionnaires were established with the help of a sleep physician, and the chosen ones were the Epworth Sleepiness Scale, STOP-Bang, Pittsburgh Sleep Quality Index, and Morningness-Eveningness-Stability-Scale improved.

A sleep disorders study was conducted for the adult Portuguese population, whereas stratified sampling was used to achieve representative values for each district of Portugal.

After one year of disclosure, 2087 complete answers were collected, 73.93% of the participants are female, only 34.49% have normal weight, and most of them are young and middle age. Participants range in age from 18 to 78 years old. In terms of sleep disorders, the vast majority of participants have poor sleep quality (61.38%), 21.37% have a high risk of developing sleep apnea, 39.29% have excessive daytime sleepiness, 57.74% are morning type, 36.85% are evening type, and the rest are intermediate.

After defining four research questions about sleep disorders, it was possible to prove that comparing the subjective sleep quality and the sleep quality achieved from the questionnaire, the Portuguese population is not aware of their sleep quality. Another interesting finding was that analyzing the individuals with excessive daytime sleepiness, 71.46% had bad sleep quality. Using a statistical method, it was proven that individuals with excessive daytime sleepiness have bad sleep quality. It was also evaluated the work schedule and the circadian rhythm to verify if it was adjusted. Considering the appropriate method, it was identified that the work schedule was adjusted to the individual's circadian rhythm. Finally, the risk of developing sleep apnea with excessive daytime sleepiness is around 1.8 times higher than the ones with normal daytime sleepiness. The results achieved are in agreement with what is present in the literature about sleep disorders.

Thereby, the novelty of this study is the integration of four questionnaires that evaluate different sleep disorders, apart from personal information, and the high number of responses from the Portuguese population that are representative of the different districts. In the future, the same analysis can be conducted for the usual drivers, and the sample can be increased.

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