ORIGINAL ARTICLE

Sleep Science

Sleep duration, lifestyles and chronic diseases: a cross-sectional population-based study

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ABSTRACT

Background: Adequate sleep is essential for health. Both, short and long sleep durations are associated to worse quality of life and poor health outcomes. Portugal represents a specific population model, since according to European statistics it has high rates of chronic diseases like depression, hypertension, diabetes and stroke; and low quality of life as well as low index of physical activity, while in parallel it has some other good health indicators such as: low age-standardized mortality for both genders, nutrition in terms of energy and fruit consumption, smoking and alcohol, obesity and overweight prevalence. The aim of this study was to characterize health and chronic diseases, lifestyles and quality of life in subjects with short and long sleep duration. **Methods:** A population-based cross-sectional evaluation of the third wave of follow-up of the EpiDoC Cohort was carried between 2015-2016. A sample of 5,436 adults ≥18 years, representative of the national population, self-reported their daily total sleep time. Associations between short sleep duration (SSD ≤5h), long sleep duration (LSD≥9h) and independent variables were determined. **Results:** The prevalence for SSD was high (20.7%) and the LSD (5.9%) was low. Being older, with lower education, retired and unemployed were associated to SSD and LSD (p<0.01). Being obese was associated to SSD as well as hypertension, gastrointestinal disease and hypercholesterolemia (p<0.01). SSD and LSD, were associated with diabetes (p<0.01 and p=0.03) and depression (p<0.01 and p=0.02) respectively. Cardiovascular disease (p<0.01) was associated to LSD. Multimorbidity (p<0.01) was associated to SSD. Worse quality of life and bad physical function were associated to SSD and LSD, as well as being hospitalized in the previous 12 months (p<0.01). **Conclusions:** Socio-demographic, physical activity and chronic diseases were associated to reduction and extension of sleep duration. There was no association between rheumatic diseases and cancer with sleep duration, as found in other studies. This study emphasizes the burden of self-reported SSD for Portugal, its consequences to health and the need to increase sleep awareness campaigns enhancing the importance of sleep in health. Furthermore, it emphasizes that chronic diseases risks are dependent on multiple parameters which varying in different countries or regions, imply the need of regional studies and interventions.

Keywords: Sleep; Life Style; Quality of Life; Cross-Sectional Studies; Chronic Disease; Portugal.

INTRODUCTION

Sleep is an active process providing daily restoration due to production of the fundamental anabolic hormones, involved in cellular growth and regeneration such as: growth hormone, testosterone, prolactin, etc.[1]. Sleep represents an essential element for health and well-being, including cognitive performance, physiological processes, emotion regulation, physical development, and quality of life[2].

Optimal sleep duration is a question often posed to sleep specialists, although it varies significantly between individuals, age, gender[2], and world region[3]. The value established for short sleep duration in adults has been sometimes controversial, but a National study in the United States of America (USA)[4] and other one in Brazil[5] point out to ≤6 hours, or by the recent values established by the National Sleep Foundation ≤5 hours[2]. The value established for long sleep is much more consensual, ≥9 hours[2,6]. Insufficient sleep is well recognized and declared as a "public health problem" by the Center of Disease and Control in the United States, and has high economic impact on a country's economy[7]. It has been demonstrated unequivocally that duration, timing, and quality of sleep critically affect physical and mental health, performance and safety[8].

Short and long sleep duration are positively associated with chronic diseases like obesity, type 2 diabetes, hypertension, and cardiovascular disease among adults[6,9] Several studies suggest that short sleep duration is associated with poor general health[10,11]. This association is less evident for the relationship between longer sleep duration and adverse health status: only a few studies associate poorer general health or increased risk/presence of disease with ≥9 hours of sleep[12]. Evidence between association to long sleep and poor health was only clear for mortality risk, showing a U-shaped relationship[12]. In a recent longitudinal study from a Swedish cohort this U-shaped relationship was also observed with mortality and age: among younger individuals (≤65 years) there was an increased mortality rate and a subsequent decrease in life expectancy. In older individuals (≥65 years) this association was not detected[13].

Culture, socioeconomic status and environment have an important influence on sleep duration. In a large twin study, authors determined the relative importance of environmental contributions associated to sleep duration and body mass index (BMI), accounting for genetics and shared environment. They support the environmental hypothesis that voluntary changes to usual sleep duration influence BMI independently of familial factors[14]

Eurostat data indicate that Portugal (PT) is the EU-28 country with higher rates of chronic depression and diabetes, 2nd rank in reported prescribed medicines, and in 7th rank for hypertension[15]; but the relationship to these high prevalent chronic conditions, consumptions and sleep, were not yet evaluated.

There are two possible conditions for having short sleep duration: insomnia or sleep deprivation. Since the prevalence for insomnia in PT is approximately the same as in other countries[16,17] the other option might be sleep deprivation.

The aim of this population-based study was to characterize health and chronic diseases, lifestyles and quality of life in subjects with disturbances in short and long sleep duration.

METHODS

Study population

This study is a cross-sectional evaluation of the third wave of follow-up of the EpiDoC Cohort (i.e., the EpiDoC3 study). EpiDoc3 participants who answer the "hours of sleep per day" question, were included in the current analysis. EpiDoC cohort was designed to study health determinants and outcomes, chronic non-communicable diseases and their impact in health resources consumption. The EpiDoC cohort enrolled 10,661 adults living in PT (mainland and the archipelagos of Azores and Madeira). EpiDoC sample size calculation was performed to capture health related conditions whose prevalence were of 0.5% as described elsewhere[18,19]. The study included non-institutionalized adults (≥18 years old) living in private homes in the Portuguese mainland and archipelagos (Madeira and Azores). The study sample was stratified by administrative territorial units [(NUTSII) (Norte, Centro, Lisboa & Vale do Tejo, Alentejo, Algarve, Açores archipelago (Azores) and Madeira archipelago (Madeira)], and the size of the population within each locality (<2,000; 2,000-9,999; 10,000-19,999; 20,000-99,999; and ≥100,000 inhabitants, respectively). Detailed methodology has been published[18]. EpiDoC3 study included 5,653 adult participants (Figure 1), of whom 5,436 reported their daily total sleep time. Data collection was performed from September 2015 to July 2016 by a trained research assistant team who randomly called all individuals by telephone.

EpiDoC cohort measurements

Sociodemographic and socioeconomic characteristics

Information regarding sociodemographic factors (sex, age, ethnicity, years of education, marital status, household composition, Nomenclature of Territorial Units for Statistics [NUTS]II region), as well as socioeconomic variables (employment status), were collected in the EpiDoC1 study. During the EpiDoC3 interview, subjects were asked whether any of these characteristics had changed. The variable age was also categorized as <65 years and ≥65 years of age, since there are important changes in sleep duration and architecture during the life span and after retirement[2,13].

Lifestyle characteristics

The daily total sleep time was assessed by the question *"On average, how many hours do you sleep per day?"* and the sleep categories were established as short sleep duration (SSD) (≤5h), normal sleep duration (NSD) (>5h and <9h) and long sleep duration (LSD) (≥9h), according to the National Sleep Foundation[2].

Self-reported height and weight were collected. Based on these data, body mass index (BMI; weight/height^2 in kg/m^2) was calculated and categorized according to the World Health

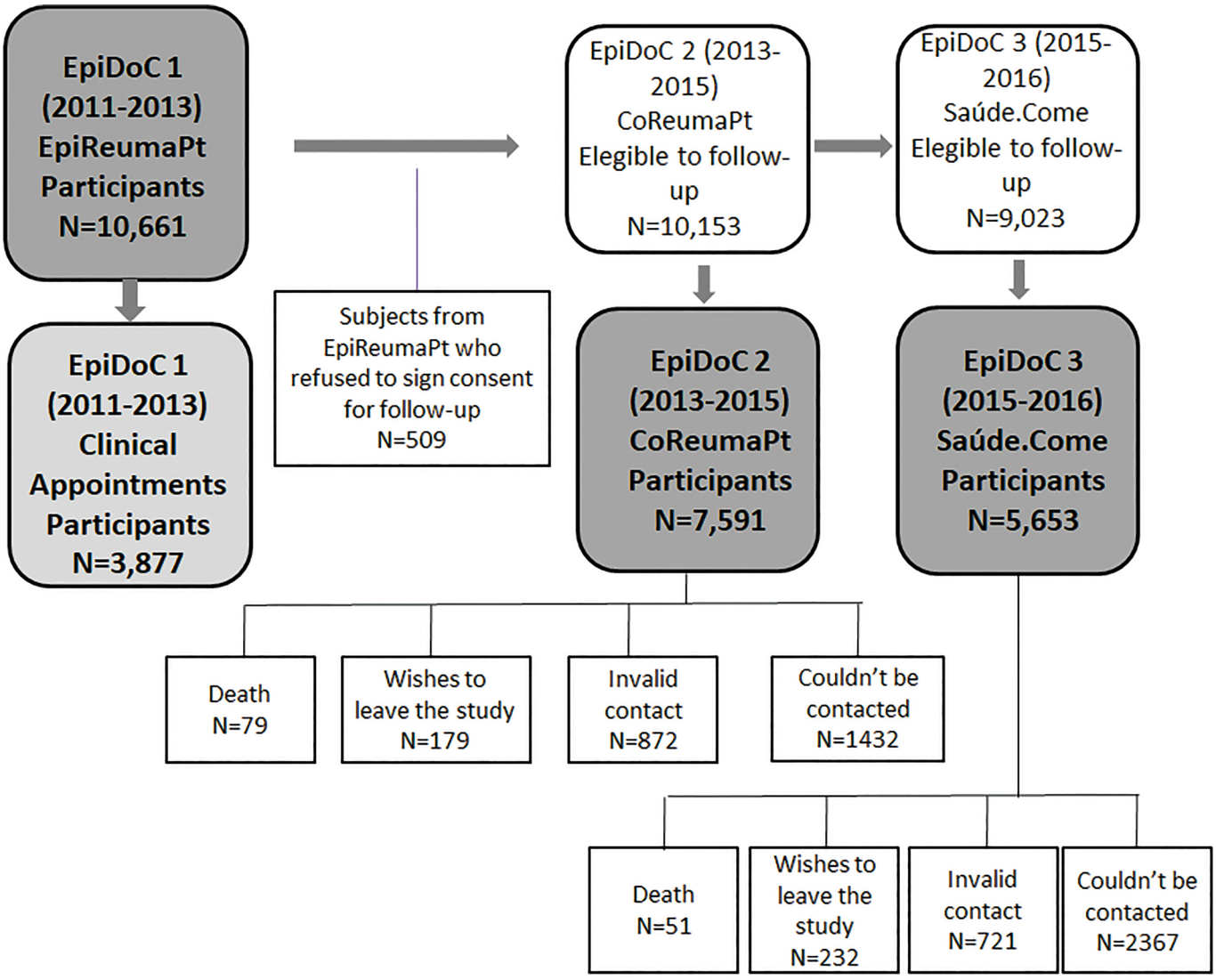

Figure 1. Flowchart of the study.

Organization (WHO) classification system[20] EpiDoC3 study included several questions concerning lifestyle habits, such as frequency of alcohol intake (never, daily, occasionally), smoking habits (current smoker, past smoker and never smoked), physical activity and dietary habits. Physical activity level was classified according to self-reported weekly frequency of physical activity and categorized by active or inactive. For the time watching TV a categorical variable was used (<5 hours/day or ≥5 hours/day). For the dietary intake, a proxy of healthy diet was assessed by calculating the adherence to the Mediterranean diet through the PREDIMED score[21].

Health characteristics and healthcare consumption and costs

In EpiDoC3 study, individuals were asked whether they had been previously diagnosed with the following chronic diseases: hypercholesterolemia, hypertension, rheumatic disease, allergy, gastrointestinal disease, cardiac disease, diabetes, pulmonary disease, cancer, or neurologic disease, depression and anxiety. Multimorbidity was defined as the coexistence of two or more of these self-reported chronic diseases[22]. Health-related quality of life was assessed using the European Quality of Life questionnaire with five dimensions and three levels (EQ-5D-3L)[23,24], for which a higher score corresponds to a higher quality of life. Physical function was evaluated using the Health Assessment Questionnaire (HAQ; ranging from 0 to 3, with higher scores representing worse functional ability)[25].

We used Portuguese validated versions of the assessment scales. Number of hospitalizations were also assessed.

Statistical analysis

To verify the representativeness of the sample according to the Portuguese population (mainland and islands), we first compared the participants and non-participants of EpiDoC3 study with respect to their sociodemographic, socioeconomic, and health status characteristics. Based on this comparison, we adjusted the weights according to stratification by NUTSII region, sex, and age group. Extrapolation weights were

computed and used in the subsequent statistical analysis. These were obtained by calibrating the extrapolation weights originally designed for the EpiDoC1 study sample.

Baseline characteristics of the study cohort were described according to the three categories of reported sleep duration: SSD (≤5h), NSD (>5h and <9h) and LSD (≥9h).

Absolute frequencies and weighted proportions were used to summarize categorical variables. Continuous variables were described by weighted mean values and standard deviations. Differences in baseline variables across categories of reported sleep duration were statistically assessed using the Student t-test for continuous variables and the Chi-square test for categorical variables. For the post-hoc comparisons between groups the Sheffé's method was used. Logistic regression was used to computed odds ratio (OR) and respective 95% confidence intervals (95% CI) to quantify the association between explanatory variable and sleep duration SSD and LSD. Crude and gender, age (<65 years *vs* ≥65 years), NUTSII and educational level adjusted OR were estimated. All analyses were weighted and performed using STATA IC v.12 (StataCorp. 2011. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP).

Ethical issues and personal protection

Details of ethical issues of the EpiDoC1 (EpiReumaPt) study were described elsewhere[18,19,26]. The study was reviewed and approved by the National Committee for Data Protection (*Comissão Nacional de Proteção de Dados*) and by NOVA Medical School Ethics Committee. Informed consent was obtained from all individual participants included in all phases of the study.

EpiDoC3 was also approved by the National Committee for Data Protection (in accordance with the Portuguese law number 67/98, October 26th, regarding protection of personal data) and by the same Ethics Committee as EpiDoC1. The study was conducted in accordance with the applicable laws and regulations including, but not limited to, the Guidelines for Good Clinical Practice and the ethical principles stated in the Declaration of Helsinki[27]. Participants' confidentiality was safeguarded by the absence of identifiers in the database (only a unique identification code was used for each participant). The name and contact information for each subject were stored separately from the study data transmitted to the coordinating center (based at the headquarters of the Portuguese Society of Rheumatology). All data were kept anonymously and secured by authorized EpiDoC staff.

RESULTS

In total, 5,436 participants reported their daily total sleep time. Participants' mean age was 56.7±16.4 years old and 3,473 (52.7%) were females. For the adult Portuguese population, self-reported SSD prevalence was 20.7%, and LSD prevalence was 5.9%. For the Portuguese country distribution, the region with a higher prevalence value of reported SSD was the Algarve (south of PT) (26.5%), while the Atlantic Islands of Azores have the lowest value (16.4%), and the higher prevalence of LSD (10.2%). Lisbon was the region with a higher prevalence value of normal sleep duration (75.8%). Participants with reported SSD (≤5h) were older (≥65), most frequently women, with lower education level, widowed and retired, unemployed or in a temporary work. The same pattern was found for reported LSD (≥9) (Table 1).

There is a higher percentage of overweight subjects in the SSD group, as well as people that drink alcohol on a daily basis and the ones that never smoke. The percentage of inactive and active individuals was similar for both sleep duration groups, except for the LSD with a higher prevalence in the inactive group. Subjects that adhere to a Mediterranean diet were the ones with higher percentage of reported normal sleep (78.2%), although a very high percentage of individuals did not have a high adherence to the Mediterranean diet (88.1%) according to the PREDIMED score.

The self-reported non-communicable chronic diseases with a prevalence value above 30% for the reported SSD group were: hypertension (34.6%), diabetes (39.4%), hypercholesterolemia (32.7%), pulmonary disease (31.0%), cardiac disease (33.9%), gastrointestinal disease (33.7%) and neoplasm disease (31.2%). For the reported LSD group, the self-reported non-communicable chronic diseases with higher prevalence's were: diabetes (9.4%), pulmonary disease (9.3%), cardiac disease (11.8%) and neoplasm disease (9.0%). The pathology with lower prevalence for reported normal sleep duration was diabetes with 51.2%. The percentage of individuals with anxiety was higher in the SSD group (26.1%) and the percentage of individuals with depression and anxiety was the same in the reported LSD group, 5.8%. For the SSD the percentage of individuals with depression was 31.4%.

The percentage of multimorbidity was high in the groups of SSD and LSD with 36.3% and 7.6% respectively although it was only statistically significant associated to SSD, when adjusted to age, gender, educational level and regions. For physical function, the group with SSD presented the lowest physical function (0.61±0.74), comparing to the LSD group. LSD group presented a low physical function when compared to the normal group. The number of hospitalizations in the previous 12 months was higher in the SSD group (28.1%). Asked about medication, 234 (2.8%) individuals reported specifically taking medication for sleep, and 40.3% of those belong to the SSD group.

SSD was weakly associated *"to drinking alcohol occasionally"*, never smoke and to have a high adherence to Mediterranean diet (Table 2).

Lifestyle variables weakly associated to reported LSD (≥9 hours/day) were "*to drink alcohol daily and occasionally"* (OR=0.56; 95%CI:0.39-0.81); and to watch TV ≥5 hours/day (OR=1.92; 95%CI:1.15-3.21). In the adjusted model, the only lifestyle variable associated to LSD (≥9 hours/day) was daily alcohol consumption (OR=0.62; 95%CI:0.42-0.90) (Table 2). For the remaining lifestyles studied no association was obtained for sleep duration.

Table 3 displays data on health conditions and health resources consumptions crude and adjusted for age, gender,

Table 1. Baseline characteristics by categories of short (≤5 h/day) and long (≥9h/day) sleep duration, having as reference group the normal sleep duration (6-8 h/day) for the Portuguese population.

					Post-hoc comparisons (Sheffé's method)		
					Short*Normal	Short*Long	Normal*Long
Characteristic	Short sleep duration (≤ 5 h/day)	Normal sleep duration (6-8 h/day)	Long sleep duration (≥9h/day)	*p*-value[a]	*p*-value	*p*-value	*p*-value
N (%)	1337 (20.7)	3693 (73.4)	406 (5.9)				
Sex, N (%)							
Male	411 (19.4)	1401 (75.0)	151 (5.7)	0.2514	___	___	___
Female	926 (22.0)	2292 (71.9)	255 (6.1)		___	___	___
Age, mean ± (SD)	58.5 (17.2)	46.1 (16.5)	56.3 (22.9)	<0.0001	<0.0001	___	<0.0001
Age groups, N (%)							
< 65 years	717 (15.8)	2704 (79.7)	199 (4.5)	<0.0001	<0.0001	<0.0001	<0.001
≥ 65 years	620 (36.4)	989 (53.2)	207 (10.4)		<0.0001	<0.0001	<0.0001
NUTS II region, N (%)							
North	404 (20.3)	1080 (73.7)	120 (6.0)	0.1802	___	___	___
Centre	260 (20.9)	688 (72.1)	91 (7.0)		___	___	___
Lisbon	244 (20.3)	798 (75.8)	53 (3.9)		___	___	___
Alentejo	75 (21.8)	208 (70.7)	28 (7.5)		___	___	___
Algarve	57 (26.5)	109 (66.0)	8 (7.5)		___	___	___
Azores	130 (16.4)	430 (73.4)	76 (10.2)		___	___	___
Madeira	167 (21.5)	380 (74.2)	30 (4.3)		___	___	___
BMI, mean ± (SD)	27.0 (4.7)	25.5 (4.2)	26.2 (5.5)	<0.0001	<0.0001	___	<0.0001
Education level, N (%)							
> 12 years	142 (11.0)	870 (86.7)	30 (2.4)	<0.0001	<0.0001	<0.0001	<0.0001
10-12 years	164 (13.9)	801 (80.7)	66 (5.4)		<0.0001	<0.001	___
5-9 years	263 (20.1)	767 (75.1)	64 (4.8)		___	___	<0.05
0-4 years	756 (34.7)	1244 (55.7)	239 (9.7)		<0.0001	<0.0001	<0.0001
Marital status, N (%)							
Single	134 (9.6)	713 (85.1)	57 (5.3)	<0.0001	<0.0001	<0.001	___
Married	833 (23.9)	2267 (70.3)	235 (5.7)		___	___	___
Divorced	86 (26.9)	266 (66.7)	28 (6.4)		___	___	___
Widowed	250 (39.5)	319 (51.0)	72 (9.5)		<0.0001	<0.0001	<0.001
Consensual union	34 (15.2)	126 (80.5)	12 (4.3)		___	___	___
Employment status, N (%)							
Employed full-time/ part-time/ domestic							
1023 (21.0)							
2978 (73.5)							
311 (5.6)	0.3085	___	___	___			
Retired/unemployed/ temporary work							
311 (19.4)							
710 (73.2)							
95 (7.3)		___	___	___			
Alcohol intake, N (%)							
Daily	371 (23.9)	1058 (70.8)	113 (5.3)	<0.0001	<0.0001	<0.001	<0.01
Occasionally	389 (16.0)	1487 (79.0)	115 (5.0)		___	___	___
Never	573 (23.7)	1142 (68.6)	176 (7.7)		<0.0001	<0.001	<0.01
Smoking habits, N (%)							
Current smoker	157 (14.0)	654 (81.0)	58 (5.0)	0.0003	<0.05	___	___
Past smoker	276 (21.5)	764 (72.1)	93 (6.4)		___	___	___

Continuation Table 1.

Never	901 (23.0)	2272 (70.9)	255 (6.1)		<0.001	<0.01	___
Physical activity, N (%)							
Inactive	803 (21.3)	2035 (72.4)	261 (6.4)	0.3879	___	___	___
Active	534 (20.1)	1658 (74.6)	145 (5.3)		___	___	___
Time watching TV, N (%)							
< 5 hours/per day	1170 (20.4)	3366 (74.0)	333 (5.5)	0.0961	___	___	___
≥ 5 hours/per day	163 (23.6)	318 (66.8)	71 (9.6)		___	___	___
Adherence to Mediterranean diet, N (%)							
High adherence to MD (PREDIMED ≥ 10)	122 (16.4)	439 (78.2)	40 (5.3)	0.0672	___	___	___
Low adherence to MD (PREDIMED ≤ 10)	1215 (21.3)	3254 (72.7)	366 (6.0)		___	___	___
Non-communicable chronic diseases (self-reported), N (%))							
Hypertension	585 (34.6)	1053 (58.5)	151 (6.9)	<0.0001	<0.0001	<0.0001	<0.05
Diabetes	224 (39.4)	354 (51.2)	66 (9.4)	<0.0001	<0.0001	<0.001	<0.01
Hypercholesterolemia	565 (32.7)	1054 (60.2)	141 (7.2)	<0.0001	<0.0001	<0.001	___
Pulmonary disease	65 (31.0)	113 (59.7)	20 (9.3)	0.0010	<0.05	<0.05	___
Cardiac disease	218 (33.9)	359 (54.4)	90 (11.8)	<0.0001	<0.001	<0.0001	<0.0001
Gastrointestinal disease	190 (33.7)	287 (58.8)	47 (7.5)	<0.0001	<0.0001	<0.001	___
Neurologic disease	54 (18.3)	129 (74.9)	19 (6.8)	0.7257	___	___	___
Allergy	135 (18.5)	371 (76.7)	28 (4.8)	0.4468	___	___	___
Neoplasm disease	93 (31.2)	181 (59.8)	31 (9.0)	0.0045	<0.05	___	___
Rheumatic disease	154 (25.9)	296 (65.8)	43 (8.4)	0.0497	<0.01	<0.05	___
Depression	141 (31.4)	265 (59.1)	37 (5.8)	<0.0001	<0.01	<0.05	___
Anxiety	79 (26.1)	159 (65.7)	23 (5.8)	0.1338	___	___	___
Multimorbidity, N (%)							
Yes	532 (36.3)	899 (56.1)	142 (7.6)	<0.0001	<0.0001	<0.0001	<0.01
No	698 (16.0)	2585 (79.2)	207 (4.8)		<0.0001	<0.001	<0.05
Hospitalized in previous 12 months, N (%)							
212 (28.1)							
425 (61.9)							
70 (10.0)	<0.0001	<0.01	<0.05	<0.05			
Physical function, mean + (SD)							
HAQ score (0-3)	0.6 (0.7)	0.3 (0.5)	0.5 (0.7)	<0.0001	<0.0001	<0.01	<0.0001
Quality of life, mean + (SD)							
EQ-5D-3L score	0.7 (0.3)	0.8 (0.2)	0.7 (0.3)	<0.0001	<0.0001	___	<0.0001
Drugs for sleep (self- reported) , N (%)							
Yes	93 (40.3)	122 (53.1)	19 (6.6)	<0.0001	<0.0001	<0.01	___
No	1244 (20.2)	3571 (74.0)	387 (5.9)		___	___	___

[a]Anova and Pearson Qui[2] tests.

NUTSII regions and educational level. To be overweight or obese (OR=1.57; 95%CI:1.24-1.99) was statistically significant associated to reported short sleep duration. Diabetes and depression presented higher prevalence values for SSD and LSD presenting an increased risk for both conditions. Hypercholesterolemia had an increased risk for SSD (OR=1.47; 95%CI:1.16-1.86). Gastrointestinal disease presented also an increased risk for the same group (OR=1.68; 95%CI:1.19-2.37). Cardiac disease was associated to LSD (OR=2.01; 95%CI:1.45-2.78).

For the remaining chronic diseases studied like rheumatic, neoplastic and pulmonary diseases there was an association to sleep duration only in the univariate analysis, this association was not found for the adjusted analysis. Allergic and neurologic diseases had no association to SSD and LSD in this population (Table 3).

Table 2. Lifestyles factors associated with short and long sleep durations for the Portuguese population.

	Crude		Multivariable adjusteda	
	Sleep duration (≤ 5 h/day vs 6-8h/day)	Sleep duration (≥ 9h/day vs 6-8 h/day)	Sleep duration (≤ 5 h/day vs 6-8h/day)	Sleep duration (≥ 9h/day vs 6-8 h/day)
	OR 95 % CI	OR 95 % CI	OR 95 % CI	OR 95 % CI
Alcohol intake				
Daily	0.98 0.73-1.31	**0.67 0.48-0.93**	0.99 0.75-1.32	**0.62 0.42-0.90**
Occasionally	**0.59 0.45-0.77**	**0.56 0.39-0.81**	0.87 0.67-1.13	0.80 0.56-1.15
Smoking habits				
Past smoker	0.92 0.70-1.21	1.03 0.75-1.42	0.99 0.74-1.33	1.20 0.81-1.77
Never	**0.53 0.39-0.72**	0.72 0.46-1.11	0.75 0.53-1.07	1.05 0.65-1.68
Physical activity				
Active	0.91 0.73-1.15	0.82 0.61-1.10	1.11 0.89-1.39	1.02 0.76-1.37
Time watching TV				
≥ 5 hours/per day	1.28 0.77-2.13	**1.92 1.15-3.21**	0.78 0.52-1.17	1.25 0.80-1.96
Mediterranean diet				
High adherence to MD (PREDIMED ≥ 10)	**0.71 0.53-0.97**	0.83 0.53-1.30	0.79 0.56-1.10	0.85 0.54-1.33

[a]Odds ratios from logistic regression model adjusted for age, sex, NUTS II regions and educational level.

Table 3. Health and health resources consumption factors associated with short and long sleep durations for the Portuguese population.

	Crude		Multivariable adjusteda	
	Sleep duration (≤ 5 h/day vs. 6-8h/day)	Sleep duration (≥ 9h/day vs. 6-8 h/day)	Sleep duration (≤ 5 h/day vs. 6-8h/day)	Sleep duration (≥ 9h/day vs. 6-8 h/day)
	OR 95 % CI	OR 95 % CI	OR 95 % CI	OR 95 % CI
Drugs for sleep (self- reported)				
Yes	**0.36 0.25-0.52**	0.64 0.36-1.16	**0.62 0.42-0.91**	1.12 0.62-2.03
BMI				
Overweight and obese				
(≥ 25 kg/m^2)	**2.01 1.59-2.54**	1.29 0.95-1.74	**1.57 1.24-1.99**	1.00 0.72-1.38
Non-communicable chronic diseases (self-reported)				
Hypertension	**2.86 2.27-3.60**	**1.75 1.32-2.33**	**1.43 1.11-1.83**	0.98 0.74-1.31
Diabetes	**3.10 2.20-4.36**	**2.58 1.82-3.66**	**1.60 1.15-2.24**	**1.48 1.04-2.10**
Hypercholesterolemia	**2.53 2.01-3.18**	**1.77 1.33-2.36**	**1.47 1.16-1.86**	1.11 0.82-1.49
Pulmonary disease	**1.88 1.26-2.80**	**2.00 1.14-3.52**	1.13 0.77-1.67	1.22 0.68-2.18
Cardiac disease	**2.45 1.74-3.46**	**3.15 2.27-4.37**	1.42 0.99-2.03	**2.01 1.45-2.78**
Gastrointestinal disease	**2.22 1.57-3.15**	**1.69 1.04-2.74**	**1.68 1.19-2.37**	1.40 0.88-2.24
Neurologic disease	0.86 0.56-1.33	1.14 0.55-2.36	0.75 0.45-1.25	1.04 0.49-2.19
Allergy	0.84 0.59-1.20	0.77 0.43-1.38	1.16 0.84-1.62	0.99 0.53-1.83
Neoplastic disease	**1.91 1.17-3.12**	**1.95 1.22-3.12**	1.15 0.71-1.87	1.29 0.80-2.09
Rheumatic disease	1.43 0.95-2.14	**1.65 1.07-2.54**	1.08 0.75-1.55	1.36 0.88-2.09
Depression	**1.98 1.47-2.67**	**2.16 1.36-3.42**	**1.56 1.16-2.11**	**1.77 1.08-2.88**
Anxiety	1.43 1.00-2.06	1.60 0.75-3.39	1.29 0.86-1.94	1.39 0.60-3.23
Multimorbidity				
Yes	**3.20 2.51-4.08**	**2.24 1.67-3.01**	**1.56 1.20-2.02**	1.28 0.94-1.76
Physical function				
HAQ score	**2.84 2.37-3.41**	**2.32 1.87-2.88**	**1.75 1.42-2.15**	**1.58 1.22-2.05**
Quality of life				
EQ-5D-3L score	**0.20 0.14-0.28**	**0.53 0.35-0.79**	**0.15 0.10-0.23**	**0.31 0.20-0.50**
Hospitalised in previous 12 months	**1.71 1.33-2.20**	**2.23 1.56-3.19**	**1.36 1.05-1.76**	**1.83 1.25-2.70**

[a]Odds ratios from logistic regression model adjusted for age, sex, NUTS II regions and educational level.

Multimorbidity presented only an increased risk for SSD in the adjusted model (OR=1.56; 95%CI:1.20-2.02). The relationship between sleep duration and mean number of comorbidities for the Portuguese population is showed in Figure 2.

Physical function and quality of life were reduced for both groups (SSD: OR=1.75; 95%CI:1.42-2.15; LSD: OR=1.58; 95%CI:1.22-2.05) and (SSD: OR=0.15; 95%CI:0.10-0.23; LSD: OR=0.31; 95%CI: 0.20-0.50) respectively, indicating that poor sleep is related to poor quality of life and poor physical functioning. As a proxy for the costs for the National Health Care System we used the number of hospitalizations in the previous twelve months; both groups presented an increased risk of being hospitalized in the previous twelve months to the inquire (SSD: OR=1.36; 95%CI:1.05-1.76; LSD: OR=1.83; 95%CI:1.25-2.70) (Table 3).

Splitting the sample in two groups, bellow and above 65 years, some differences were found. Marital status was (p<0.0001) only associated to sleep duration in the age group bellow 65 years, with a high percentage of divorced people in the SSD group. Also, a higher percentage of retired/unemployed or with a temporary work was associated to SSD in this age group (p=0.0198); and the alcohol intake (p=0.0157) was also higher for SSD. More statistically significant associations in this age group were found in non-communicable chronic diseases: diabetes (p<0.0001), hypercholesterolemia (p<0.0001), gastrointestinal disease (p=0.0001), rheumatic diseases (p=0.0191), depression (p<0.0001) and anxiety (p=0.0477). A higher number of hospitalizations (p=0.0007) and a higher use of drugs for sleep was associated to SSD for the age group < 65 years. The only variable associated to sleep duration for the age group ≥ 65 was the adherence to Mediterranean diet, where participants with a lower adherence were more present in the SSD group (Table 4).

For the <65 years group the lifestyle factors with a predictive value for SSD were being married (OR=1.95; 95%CI:1.33-2.86), divorced (OR=1.26; 95%CI:1.26-3.56) and widowed (OR=4.59; 95%CI:2.51-8.37); and for LSD only to consume alcohol daily (OR=0.41; 95%CI:0.24-0.70). For the ≥ 65 years group they were, for SSD, never smoked (OR=0.39; 95%CI:0.16-0.96) and the high adherence to the Mediterranean diet (OR=0.56; 95%CI:0.36-0.86). For the LSD it was being active (OR=0.60; 95%CI:0.39-0.92) (Table 5).

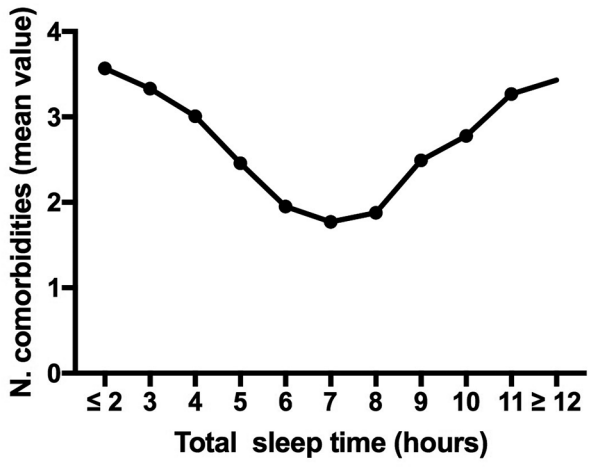

Figure 2. Relationship between sleep duration and chronic diseases.

For the < 65 years group the health and health resources consumption factors with a predictive value to SSD were the consumption of drugs for sleep (OR=0.44; 95%CI:0.24-0.80), to be obese (OR=1.74; 95%CI:1.30-2.32), to be hypertense (OR=1.80; 95%CI:1.36-2.39), to have diabetes (OR=2.14; 95%CI:1.41-3.23), to have hypercholesteremia (OR=1.98; 95%CI:1.52-2.58), to have a cardiac disease (OR=1.75; 95%CI:1.06-2.88), to suffer from a gastrointestinal disease (OR=2.20; 95%CI:1.42-3.41), depression (OR=2.14; 95%CI:1.48-3.08), multimorbidity (OR=2.28; 95%CI:1.75-2.97), worse physical function (OR=2.46; 95%CI:1.98-3.05), worse quality of life (OR=0.30; 95%CI:0.14-0.38) and the number of hospitalizations in the previous 12 months (OR=1.48; 95%CI:1.04-2.10); for the LSD they were to suffer from a rheumatic disease (OR=1.88; 95%CI:1.06-3.33), depression (OR=2.55; 95%CI:1.16-4.35), worse physical function (OR=1.74; 95%CI:1.21-2.50), worse quality of life (OR=0.30; 95%CI:0.15-0.60) and to be hospitalized in the previous 12 months (OR=2.19; 95%CI:1.26-3.80).

For the ≥65 years group the health and health resources consumption factors with a predictive value to SSD were to be hypertense (OR=1.57; 95%CI:1.07-2.31), to suffer from cardiac disease (OR=1.54; 95%CI:1.00-2.37), multimorbidity (OR=2.06; 95%CI:1.41-3.02) and worse physical function (OR=1.56; 95%CI:1.14-2.12. For the LSD they were to suffer from a cardiac disease, worse physical function (OR=1.50; 95%CI:1.06-2.11) and quality of life (OR=0.30; 95%CI:0.17-0.52) (Table 6).

DISCUSSION

The associations to chronic diseases and abnormal total sleep time namely SSD were found for PT. The prevalence for SSD in PT is very high, contrary to LSD. In the USA, data from the National Health Interview Survey, for the same cut-off value (≤5h/day) the prevalence was much lower, 7.8%[28], and in a sample of the Brazilian population, the prevalence value for reported SSD with a cut-off value of ≤6h/day, was 15.8%[5]. The prevalence value for LSD (≥9h/day) in PT is low (5.9%) if compared with the USA (8.5%) and even lower than the Brazilian cohort (21.9%)[5]. The metropolitan area of Lisbon, the most populated urban region of the all country, with a high 24h/7days rhythm, was the region with a higher prevalence value of NSD (75.8%). No explanation for this result was found, as so, future studies evaluating sleep duration comparing urban and rural areas should be performed in PT.

Diabetes and depression presented a significant association with SSD and LSD with an increased risk for both conditions. This was also found in the USA [9]diabetes, and cardiovascular disease; and although 7-8 h of sleep seems to confer the least health risk, these findings are often based on non-representative data. We hypothesize that short sleep (<7 h in Brazil[5], and in a recent revision study[6]. This is in line with the very high prevalence of both in the country[29]. PT has the

Table 4. Baseline characteristics by categories of short (≤5 h/day) and long (≥9h/day) sleep duration, having as reference group the normal sleep duration (6-8 h/day) for age groups (< 65years and ≥65 years).

	Age group < 65 years				Age group ≥65 years			
Characteristic	Short sleep duration (≤5 h/day)	Normal sleep duration (6-8 h/day)	Long sleep duration (≥ 9h/day)	*p*-value[a]	Short sleep duration (≤ 5 h/day)	Normal sleep duration (6-8 h/day)	Long sleep duration (≥ 9h/day)	*p*-value[a]
N (%)	717 (19.8)	2704 (74.7)	199 (5.5)		620 (34.1)	989 (54.5)	207 (11.4)	
Sex, N (%)								
Male	501 (17.1)	1653 (78.4)	129 (4.6)	0.2605	425 (36.5)	639 (52.8)	126 (10.7)	0.9130
Female	216 (14.4)	1051 (81.2)	70 (4.4)		195 (36.2)	350 (53.8)	81 (10.0)	
Age, mean ± (SD)	47.6 (12.2)	40.2 (11.7)	41.8 (14.8)	<0.0001	73.6 (6.0)	74.2 (6.8)	76.1 (7.9)	0.0014
NUTS II region N(%)								
North	225 (15.7)	831 (79.4)	65 (4.9)	0.1755	179 (37.4)	249 (52.7)	55 (9.9)	0.0840
Centre	131 (16.0)	476 (79.4)	35 (4.6)		129 (33.4)	212 (53.2)	56 (13.4)	
Lisbon	127 (14.1)	583 (83.0)	28 (3.0)		117 (42.0)	215 (50.9)	25 (7.1)	
Alentejo	40 (20.1)	125 (74.4)	12 (4.7)		35 (23.7)	83 (63.0)	16 (13.3)	
Algarve	22 (18.7)	68 (72.3)	6 (9.0)		35 (46.9)	41 (49.4)	2 (3.6)	
Azores	81 (13.6)	338 (78.6)	40 (7.8)		49 (28.0)	92 (52.1)	36 (19.9)	
Madeira	91 (16.9)	283 (79.9)	13 (3.2)		76 (40.3)	97 (8.5)	17 (8.5)	
BMI, mean ± (SD)	26.9 (5.1)	25.2 (4.1)	25.5 (5.3)	<0.0001	27.1 (3.8)	26.8 (4.3)	27.2 (5.2)	0.0097
Education level, N (%)								
> 12 years	115 (10.4)	782 (87.5)	23 (2.1)	<0.0001	27 (18.8)	88 (75.9)	7 (5.3)	<0.0001
10-12 years	136 (13.3)	730 (81.7)	52 (5.1)		28 (24.9)	71 (64.6)	14 (10.5)	
5-9 years	197 (19.4)	629 (76.2)	42 (4.4)		66 (24.5)	138 (68.2)	22 (7.4)	
0-4 years	266 (25.9)	558 (66.7)	80 (7.4)		490 (40.7)	686 (48.2)	159 (11.2)	
Marital status, N (%)								
Single	108 (9.2)	665 (85.7)	46 (5.1)	<0.0001	26 (21.2)	48 (66.6)	11 (12.2)	0.5327
Married	460 (19.3)	1643 (76.7)	114 (4.0)		373 (35.3)	624 (54.5)	121 (10.2)	
Divorced	63 (20.5)	211 (73.7)	20 (5.8)		23 (47.0)	55 (44.7)	8 (8.4)	
Widowed	55 (41.3)	61 (54.7)	8 (4.0)		195 (39.1)	258 (50.1)	64 (10.8)	
Consensual union	31 (14.7)	122 (81.3)	11 (4.5)		3 (34.3)	4 (48.6)	1 (17.2)	
Employment status, N (%)								
Employed full-time/part-time/ domestic	483 (15.1)	2095 (81.1)	128 (3.9)	0.0198	540 (36.9)	883 (52.9)	183 (10.2)	0.5384
Retired/unemployed/ temporary work	233 (17.9)	607 (75.5)	71 (6.7)		78 (31.2)	103 (56.3)	24 (12.5)	
Alcohol intake, N (%)								
Daily	283 (18.1)	755 (75.9)	81 (6.0)	0.0157	290 (37.1)	387 (51.2)	95 (11.7)	0.7278
Occasionally	179 (17.0)	704 (80.0)	40 (3.0)		192 (36.7)	354 (53.7)	73 (9.6)	
Never	253 (13.7)	1240 (81.9)	78 (4.4)		136 (33.9)	247 (9.6)	37 (9.4)	
Smoking habits, N (%)								
Current smoker	443 (16.9)	1565 (78.9)	104 (4.2)	0.3933	458 (38.0)	707 (51.2)	151 (10.9)	0.2133
Past smoker	141 (15.9)	532 (78.9)	49 (5.2)		135 (35.4)	232 (55.2)	44 (9.5)	
Never	132 (13.4)	605 (82.0)	46 (4.5)		25 (22.0)	49 (9.5)	12 (9.3)	
Physical activity, N(%)								
Inactive	413 (16.3)	1442 (79.6)	113 (4.2)	0.6342	390 (35.0)	593 (52.6)	148 (12.4)	0.1156
Active	304 (15.3)	1262 (79.9)	86 (4.9)		230 (38.5)	396 (54.3)	59 (10.4)	
Time watching TV, N (%)								
< 5 hours/per day	655 (15.8)	2562 (80.0)	171(4.3)	0.3449	515 (37.4)	804 (52.5)	162 (10.1)	0.5578
≥ 5 hours/per day	60 (16.0)	139 (76.3)	28 (7.7)		103 (32.5)	179 (55.7)	43 (11.8)	
Adherence to Mediterranean diet, N (%)								

Continuation Table 4.

High adherence to MD (PREDIMED ≥ 10)	68 (14.0)	327 (82.3)	20 (3.4)	0.4111	54 (25.2)	112 (62.6)	20 (10.4)	0.0372
Low adherence to MD (PREDIMED ≤ 10)	649 (16.1)	2377 (79.3)	179 (4.6)		566 (37.7)	877 (52.1)	187 (10.2)	
Non-communicable chronic diseases (self-reported), N (%)								
Hypertension	218 (26.7)	530 (69.1)	50 (4.2)	<0.0001	367 (41.7)	523 (48.9)	101 (9.4)	0.0238
Diabetes	75 (32.3)	144 (61.3)	19 (6.4)	<0.0001	149 (44.1)	210 (44.6)	47 (11.3)	0.0689
Hypercholesterolemia	245 (26.2)	597 (68.2)	55 (5.6)	<0.0001	320 (40.9)	457 (50.0)	86 (9.8)	0.1583
Pulmonary disease	26 (25.0)	65 (70.7)	4 (4.3)	0.0803	39 (38.4)	48 (46.3)	16 (15.3)	0.3096
Cardiac disease	62 (24.0)	155 (69.8)	21 (6.3)	0.0147	156 (40.7)	204 (43.8)	69 (15.6)	0.0097
Gastrointestinal disease	98 (28.7)	164 (66.2)	20 (5.1)	0.0001	92 (42.4)	123 (46.1)	27 (11.5)	0.2634
Neurologic disease	27 (14.5)	98 (79.6)	10 (4.5)	0.7730	27 (30.2)	31 (60.3)	9 (9.6)	0.6007
Allergy	90 (15.9)	310 (80.9)	12 (4.5)	0.6601	45 (35.9)	61 (48.7)	16 (15.3)	0.2834
Neoplasm disease	34 (20.0)	98 (76.4)	7 (3.7)	0.4149	59 (41.9)	83 (44.0)	24 (14.1)	0.2785
Rheumatic disease	89 (18.8)	204 (73.3)	24 (8.0)	0.0191	65 (41.2)	92 (49.6)	19 (9.2)	0.6672
Depression	89 (30.0)	181 (61.6)	20 (4.5)	<0.0001	52 (34.6)	84 (53.3)	17 (12.1)	0.7781
Anxiety	51 (25.0)	113 (68.7)	9 (6.4)	0.0477	28 (30.5)	46 (55.0)	14 (14.5)	0.4362
Multimorbidity, N (%)								
Yes	281 (26.9)	696 (67.9)	65 (5.2)	<0.0001	369 (43.3)	534 (47.4)	107 (9.3)	0.0003
No	367 (12.4)	1878 (83.6)	115 (4.1)		175 (28.2)	314 (63.2)	51 (8.6)	
Hospitalized in previous 12 months N(%)	89 (20.9)	266 (70.1)	26 (8.4)	0.0007	123 (40.1)	159 (47.4)	44 (10.4)	0.1925
Physical function, mean ± (SD)								
HAQ score (0-3)	0.4 (0.7)	0.2 (0.4)	0.3 (0.6)	<0.0001	0.8 (0.7)	0.6 (0.7)	0.8 (0.7)	<0.0001
Quality of life, mean ± (SD)								
EQ-5D-3L score	0.6 (0.3)	0.9 (0.2)	0.8 (0.3)	<0.0001	0.6 (0.3)	0.7 (0.3)	0.5 (0.3)	<0.0001
Drugs for sleep (self- reported), N(%)								
Yes	35 (36.2)	48 (59.4)	4 (4.4)	0.0002	58 (43.8)	74 (47.7)	15 (8.5)	0.2720
No	682 (15.4)	2656 (80.1)	195 (4.5)		562 (35.9)	915 (53.6)	192 (10.5)	

[a]Anova and Pearson Qui^2 tests

highest prevalence of diabetes when compared with European countries[29]; in our data the crude odds ratio is 3.10 for SSD and 2.58 for LSD; these values are lower, but still significant for the multivariable adjusted model. In clinical terms these associations reflect a share of sleep duration in the risk of diabetes, although other factors such as low physical activity also shown in our study, must have significant contributions.

The prevalence of depression in PT is among the highest values in the WHO European Region (5.7%), since only Ukraine and Estonia present higher values[30] The odds ratio between depression and SSD is 1.98 and LSD is 2.16 for the crude analysis, with values a bit lower but significant for the multivariable adjusted model; in our sample the influence of age, gender, region and education in the association between sleep duration and depression is minor when compared with diabetes. However in the sub-sample of older adults from the EpiDoc cohort, the prevalence of depression is higher in the elder (11.8%)[31] when compared to WHO data[30].

Obesity was a predictor for SSD. These results were in accordance with previous studies[6,9,32] in a twin study[14] and also in adolescents[33]. The mean BMI for Portuguese males and females was 26.7kg/m^2 and 25.7kg/m^2 respectively; the prevalence of obesity was in 2014 19.8% for males and 20.3% for females. In fact these data are a bit lower when compared with the mean EU data[29], and therefore this low obesity prevalence may explain the low odds ratio values found. For LSD, in the adjusted model, this association was not found, contrary as observed in other studies; LSD was associated with an increased sedentary behavior, inactivity, and obesity[6,32]. Abdominal fat, besides being a health risk by itself for cardiometabolic diseases[34], the waist circumference was not measured, although the association to BMI is well established[35].

The adherence to Mediterranean diet was analyzed as a proxy of healthy diet. Although being a protective variable to SSD, in the adjusted analysis this association was not found. A previous study resulting from an analysis of the adherence to the Mediterranean diet between 1961 and 2003 had already showed that the adherence to Mediterranean diet has gradually declined in the last years in the Portuguese population[36].

In the USA's, the U-shaped risk was observed for hypertension and cardiovascular disease[9]. In our study hypertension had an increased risk only for SSD and cardiovascular

Table 5. Lifestyles factors associated with short and long sleep durations for age groups (< 65 and ≥ 65 years).

	<65 years				≥65 years			
	Crude		Multivariable adjusted[a]		Crude		Multivariable adjusted[a]	
	Sleep duration (≤5 h/day vs. 6-8h/day)	Sleep duration (≥9h/day vs. 6-8 h/day)	Sleep duration (≤5 h/day vs. 6-8h/day)	Sleep duration (≥9h/day vs. 6-8 h/day)	Sleep duration (≤5 h/day vs. 6-8h/day)	Sleep duration (≥9h/day vs. 6-8 h/day)	Sleep duration (≤5 h/day vs. 6-8h/day)	Sleep duration (≥9h/day vs. 6-8 h/day)
	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI				
Alcohol intake								
Daily	0.89 0.65-1.23	**0.47 0.29-0.77**	0.97 0.69-1.38	**0.41 0.24-0.70**	0.94 0.60-1.49	0.78 0.50-1.21	0.99 0.61-1.60	0.89 0.53-1.49
Occasionally	**0.70 0.51-0.97**	0.68 0.43-1.08	0.83 0.61-1.13	0.74 0.48-1.45	0.82 0.56-1.21	0.72 0.42-1.22	1.06 0.70-1.58	0.77 0.44-1.34
Smoking habits								
Past smoker	0.94 0.69-1.28	1.24 0.79-1.95	0.91 0.69-1.37	1.36 0.81-2.27	0.86 0.54-1.38	0.81 0.52-1.25	0.92 0.54-1.55	0.91 0.52-1.59
Never	0.76 0.55-1.06	1.08 0.65-1.81	0.83 0.57-1.20	1.19 0.70-2.04	**0.41 0.20-0.91**	0.64 0.25-1.61	**0.39 0.16-0.96**	0.56 0.19-1.64
Physical activity								
Active	0.93 0.72-1.21	1.17 0.78-1.72	1.07 0.82-1.39	1.33 0.90-1.96	1.07 0.71-1.61	**0.57 0.38-0.85**	1.17 0.78-1.73	**0.60 0.39-0.92**
Time watching TV								
≥5 hours/per day	1.06 0.52-2.20	1.89 0.84-4.26	0.87 0.47-1.62	1.63 0.78-3.42	0.82 0.48-1.40	1.10 0.68-1.79	0.74 0.46-1.21	1.06 0.63-1.78
Marital status								
Married	**2.36 1.60-3.51**	0.87 0.55-1.35	**1.95 1.33-2.86**	0.66 0.41-1.05	2.04 0.89-4.67	1.02 0.39-2.69	2.01 0.78-5.22	1.02 0.37-2.85
Divorced	**2.60 1.54-4.41**	1.32 0.67-2.58	**2.12 1.26-3.56**	0.91 0.46-1.80	3.31 0.85-12.96	1.02 0.30-3.51	3.52 0.97-12.77	1.21 0.32-4.52
Widowed	**7.06 3.89-12.82**	1.24 0.42-3.62	**4.59 2.51-8.37**	0.62 0.21-1.84	**2.46 1.06-5.67**	1.17 0.43-3.23	2.13 0.80-5.62	1.08 0.37-3.13
Consensual union	1.70 0.91-3.15	0.82 0.38-1.78	1.53 0.82-2.84	0.73 0.34-1.60	2.22 0.31-16.12	1.93 0.16-23.83	3.14 0.54-18.37	2.52 0.22-28.41
Mediterranean diet								
High adherence to MD (PREDIMED ≥ 10)	0.84 0.56-1.24	0.71 0.39-1.31	0.88 0.57-1.34	0.69 0.36-1.31	**0.56 0.36-0.86**	1.00 0.51-1.93	**0.65 0.43-0.99**	1.07 0.56-2.05

[a]Odds ratios from logistic regression model adjusted for sex, NUTS II regions and educational level.

disease only for LSD. The prevalence of high blood pressure in PT is high (28.1%) in 2014, and it is the 9th highest prevalence in Europe[29], the highest values include Russian Federation, other countries from the Eastern Europe and Luxembourg. The odds ratio for SSD is high (2.86) but decreases, although remaining significant in the multivariable adjusted model (1.43); these results suggest that sleep reduction is included in a set of other risk factors for hypertension. The age standardized prevalence for 100,000 inhabitants of cardiovascular disease in PT in 2015 is 4,765 for females and 5,764 for males, which, within the European framework, are among the lowest values[29]. This might be a partial explanation for the absent association with SSD, which has been found by other authors in the USA[37] and Netherlands[38]. In fact this result deserves further studies since the prevalence of cardiovascular disease is similar in Netherlands and PT. For the association only to LSD to cardiovascular disease no explanation can be found since like stated by Covassin & Singh[39], experimental evidence corroborating harmful cardiovascular effects of excessive sleep duration is lacking, which contributes to making any causal association between long sleep and cardiovascular disease more elusive. Hypercholesterolemia had an increased risk for SSD in accordance to literature which indicates SSD as a risk factor for metabolic function[40,41] PT has a reasonable prevalence of raised blood cholesterol (16.7), which is much lower than in most Northern and Eastern EU countries[29] and USA[42]. The Mediterranean diet might be an explanation in spite of the reduced adherence. Contrary to a previous study[5] rheumatic diseases were not associated with sleep duration. Most of the rheumatic diseases are inflammatory diseases so, an association namely to SSD was expected[43]. The same happened to cancer, in this population an association with sleep duration was not found. The association to sleep duration and cancer, namely for LSD, was described in studies for cancer related mortality[44,45]. In this study, there was an increased risk for neoplasm disorders in SSD and LSD, although, adjusting for age, gender, regions and educational level this association was not found; the low prevalence of LSD may be a possible explanation, as well as the low rates of cancer for PT comparing to other countries[15]. The reduced immunological defenses in individuals with short or increased sleep durations was demonstrated by Patel et al.[46] in a study where pneumonia risk was higher for these individuals; in our study pulmonary disease, had an association in the univariate analysis, which was missed in the adjusted data. An association with SSD was however expected since the chronic obstructive pulmonary disease is usually one of the most prevalent pulmonary diseases and is associated to SSD[47,48]. Even separating by age groups below and above 65 years this association was still not found.

Anxiety is usually associated to insomnia; nevertheless in this population the association to SSD was not found, only in the group <65 years this association was present[49].

Table 6. Health and health resources consumption factors associated with short and long sleep durations for age groups (<65 and ≥65 years).

	<65 years				≥65 years			
	Crude		Multivariable adjusted[a]		Crude		Multivariable adjusted[a]	
	Sleep duration (≤5 h/day vs. 6-8h/day)	Sleep duration (≥9h/day vs. 6-8 h/day)	Sleep duration (≤5 h/day vs. 6-8h/day)	Sleep duration (≥9h/day vs. 6-8 h/day)	Sleep duration (≤5 h/day vs. 6-8h/day)	Sleep duration ≥9h/day vs. 6-8 h/day)	Sleep duration (≤5 h/day vs. 6-8h/day)	Sleep duration (≥9h/day vs 6-8 h/day)
	OR 95 % CI	OR 95 % CI	OR 95 % CI	OR 95 % CI				
Drugs for sleep (self- reported)								
Yes	**0.32 0.17-0.60**	0.76 0.26-2.23	**0.44 0.24-0.80**	0.92 0.32-2.65	0.73 0.46-1.14	1.10 0.55-2.22	0.78 0.50-1.23	1.21 0.60-2.44
BMI								
Overweight and obese								
(≥25 kg/m²)	**1.96 1.49-2.59**	1.36 0.76-1.69	**1.74 1.30-2.32**	0.99 0.66-1.49	1.33 0.86-2.07	1.02 0.63-1.64	1.26 0.83-1.90	0.99 0.60-1.64
Non-communicable chronic diseases (self-reported)								
Hypertension	**2.27 1.73-3.00**	**1.11 0.72-1.69**	**1.80 1.36-2.39**	0.90 0.59-1.37	**1.63 1.08-2.44**	1.07 0.71-1.61	**1.57 1.07-2.31**	1.10 0.72-1.69
Diabetes	**2.83 2.91-4.20**	**1.96 1.07-3.58**	**2.14 1.41-3.23**	1.54 0.85-2.78	1.63 0.99-2.66	1.47 0.94-2.28	1.52 0.99-2.32	1.44 0.92-2.24
Hypercholesterolemia	**2.34 1.80-3.04**	**1.61 1.07-2.44**	**1.98 1.52-2.58**	1.41 0.95-2.10	1.38 0.92-2.06	0.98 0.65-1.47	1.37 0.95-1.99	0.92 0.60-1.40
Pulmonary disease	**1.81 1.05-3.13**	1.11 0.38-3.25	1.36 0.80-2.29	0.86 0.29-2.54	1.22 0.69-2.17	1.76 0.89-3.50	1.26 0.70-2.27	1.56 0.73-3.31
Cardiac disease	**1.81 1.11-2.94**	1.66 0.92-1.99	**1.75 1.06-2.88**	1.63 0.94-2.83	1.49 0.95-2.35	**2.32 1.56-3.46**	**1.54 1.00-2.37**	**2.18 1.43-3.30**
Gastrointestinal disease	**2.38 1.52-3.70**	1.44 0.73-2.83	**2.20 1.42-3.41**	1.55 0.80-3.02	1.43 0.89-2.29	1.35 0.73-2.50	1.59 0.99-2.55	1.43 0.75-2.72
Neurologic disease	0.91 0.51-1.65	1.35 0.50-3.63	0.86 0.47-1.56	1.30 0.52-3.27	0.73 0.37-1.43	0.82 0.32-2.12	0.65 0.31-1.40	0.74 0.28-1.98
Allergy	1.00 0.66-1.50	0.68 0.29-1.60	1.10 0.73-1.67	0.77 0.30-1.96	1.08 0.66-1.79	1.71 0.87-3.35	1.11 0.67-1.84	1.60 0.78-3.25
Neoplastic disease	1.34 0.82-2.19	0.85 0.34-2.14	1.13 0.68-1.89	0.76 0.30-1.91	1.44 0.72-2.90	1.77 0.99-3.14	1.49 0.75-2.97	1.69 0.90-3.17
Rheumatic disease	1.31 0.91-1.90	**2.05 1.17-3.61**	1.15 0.80-1.65	**1.88 1.06-3.33**	1.25 0.61-2.50	0.95 0.51-1.77	1.18 0.65-2.14	0.88 0.47-1.64
Depression	**2.67 1.85-3.86**	**2.62 1.40-4.90**	**2.14 1.48-3.08**	**2.25 1.16-4.35**	0.94 0.58-1.54	1.22 0.63-2.36	1.03 0.64-1.66	1.34 0.68-2.64
Anxiety	**1.91 1.24-2.94**	1.71 0.57-5.14	1.70 1.09-2.66	1.58 0.49-5.10	0.80 0.44-1.45	1.42 0.61-3.27	0.75 0.41-1.37	1.31 0.54-3.19
Multimorbidity								
Yes	**2.68 2.06-4.47**	**1.58 1.02-2.45**	**2.28 1.75-2.97**	1.42 0.88-2.29	**2.05 1.40-3.00**	1.44 0.88-2.35	**2.06 1.41-3.02**	1.39 0.83-2.34
Physical function								
HAQ score	**2.97 2.43-3.64**	**2.12 1.50-3.00**	**2.46 1.98-3.05**	**1.74 1.21-2.50**	**1.63 1.21-2.21**	**1.56 1.16-2.10**	**1.56 1.14-2.12**	**1.50 1.06-2.11**
Quality of life								
EQ-5D-3L score	**0.17 0.11-0.26**	**0.24 0.12-0.47**	**0.23 0.14-0.38**	**0.30 0.15-0.60**	0.70 0.40-1.23	**0.26 0.16-0.43**	0.77 0.44-1.33	**0.30 0.17-0.52**
Hospitalised in previous 12 months	**1.56 1.11-2.20**	**2.34 1.36-4.04**	**1.48 1.04-2.10**	**2.19 1.26-3.80**	1.29 0.89-1.89	1.45 0.93-2.27	1.41 0.98-2.03	1.49 0.94-2.35

[a]Odds ratios from logistic regression model adjusted for sex, NUTS II regions and educational level.

An increased risk of multimorbidity for people reporting SSD was also found in our study like in a Brazilian cohort, where it was stated that people suffering from chronic diseases have a greater chance of exhibiting a SSD pattern, and that such individuals may have a tendency towards an accumulation of sleep problems, generating a deficiency in the normal sleep pattern[5]. In Figure 2 it was possible to observe the U shape for the relationship between sleep duration and number of comorbidities. Like in other study where 7h of sleep presented a lower mortality risk[13] also in our study 7h of sleep presented the lower number of comorbidities, increasing with higher or lower sleep time.

Poor quality of life and poor physical functioning presented an increased risk for both conditions SSD and LSD. This was also well demonstrated in a representative sample from the USA population[50]. Worse quality of life and health complaints were also reported for sleep deprivation in Portuguese adolescents[33].

The number of hospitalizations represents costs to the National Health Care System and in this study almost 30% of the total sample, had abnormal sleep (SSD or LSD) and reported to be hospitalized in the previous 12 months.

A recent study in the UK presented the economics costs of insufficient sleep across five different OECD countries: up to $680 billion are lost each year across these countries due to insufficient sleep. Insufficient sleep increases mortality risk, and the amounts of working time lost due to absenteeism or presenteeism[7]. All the countries evaluated in this study presented lower prevalence values for SSD than PT, demonstrating that this might be a very important issue for the Portuguese economy.

One of the major strengths of our study is its large sample size and representativeness with mainland and islands. The other is the fact that in the EpiDoc1 participants had a complete clinical examination performed by a physician and besides EpiDoc3 being a telephonic interview, the registries to confirm chronic diseases were consulted. Our study had also some limitations: since this is a cross-sectional study it was not possible to establish the temporal nature of the association between the tested variables and self-reported sleep duration; daily sleep duration was measured subjectively by self-report, an objective measure like actigraphy would be of great value, giving the possibility of register workdays and off-days; asking for workdays and off-days separately would be something very important since a recent study[51] showed that when asking about total sleep time duration, the answer reflects only workdays times. Sleep timing and sleep quality were also variables not considered in this study and are important factors when studying sleep. The influence of menopause was not evaluated in this study and there are clear evidences that menopause by itself influences objective sleep patterns[52].

Like in the majority of questionnaires there were some questions that the volunteers did not know or refused to answer, resulting in some missing values. However, it was not possible to eliminate those participants because the representativeness for the Portugal could be compromised.

This study screens the self-reported daily sleep duration for the Portuguese population and shows the very high prevalence of self-reported SSD in the population. Also, the increased risk for chronic diseases and the high costs for the Portuguese National Health Care System were well demonstrated, with the association between SSD and LSD with chronic diseases and with a higher number of hospitalizations. Although some of the chronic diseases that are commonly associated to SSD and LSD like rheumatic diseases and cancer were not significantly associated in this population. Looking closer to the population bellow 65 years of age some significant differences were found. Being unemployed before retirement is associated to SSD as well as being divorced and widowed, these are stress factors that can steal sleep. For some chronic diseases the association to SSD or LSD is only present in individuals bellow 65 years of age. The significant association to sleep duration and increased mortality risk only for this age group and not in older individuals was shown in a Swedish cohort[13], the same relationship might be present in our sample. In a future follow up of this cohort, this relationship should be tested for Portugal.

Future studies are needed evaluating not only reported daily total sleep time, but also the time of the day that people sleep, preferably with objective quantitative measures. Studies on interventions aimed at sleep duration should be conducted to investigate whether adverse health risks decrease in different community settings.

This study emphasizes the burden of self-reported SSD for PT, its consequences to health and the need to increase sleep awareness campaigns enhancing the importance of sleep in health.

Furthermore, it emphasizes that chronic diseases risks are dependent on multiple parameters which varying in different countries or regions, imply the need of regional studies taking into account the local specificities.

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