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Associations between sleep quality and domains of quality of life in a non-clinical sample: Results from higher-education students

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ABSTRACT

Objective: The association between sleep quality and quality of life (QoL) in clinical samples diagnosed with sleep disorders, mental disorders, or other medical conditions has been widely investigated. However, few studies focused on this relationship in samples of mostly young and healthy adults. This study analyzed the associations between sleep quality and several dimensions of QoL in higher education students and examined whether or not sleep quality would significantly predict QoL after statistically controlling for psychopathological symptoms.
Design: Observational and transversal.
Setting: Non-clinical; higher education.
Participants: A sample of 324 college students, aged 17 to 47 years ($M = 20.89 \pm 2.85$) were enrolled.
Measurements: European Portuguese versions of the Pittsburgh Sleep Quality Index (PSQI), the WHOQOL-Bref to measure QoL, and the Brief Symptom Inventory (BSI) to measure psychopathological symptoms.
Results: All PSQI components were significantly associated with general QoL and the psychological and physical QoL domains. The subjective sleep quality and daytime dysfunction PSQI components were consistently associated with all WHOQOL-Bref domains and general QoL. Hierarchical regression analyses further showed that the PSQI components as a whole, in particular subjective sleep quality, added significant contributions to the general QoL facet and to the psychological, physical, and environmental QoL domains, after controlling for psychopathological symptoms.
Conclusions: Several components of sleep quality and different facets/domains of QoL are associated in higher education students, particularly subjective sleep quality, which remains a significant predictor of most aspects of QoL, regardless of the presence of psychopathological symptoms.

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Introduction

Quality of life (QoL) refers to the "individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" (p. 1403).[1] Several studies have systematically demonstrated adverse effects when sleep behavior is compromised.[2] For example, sleep deprivation may cause emotional problems; impaired social, work, and academic performance; sleepiness; and impairment of cognitive functions, etc.[3,4]

According to the literature, the association between sleep quality and QoL in clinical samples diagnosed with sleep disorders (eg, insomnia) or other medical conditions (eg, cancer) has been extensively investigated. Notwithstanding, studies focused on the relationship between *sleep quality* and *QoL* in community samples of mostly healthy young adults are lacking despite the vast amount of publish research about the general topic of sleep and QoL. For instance, when searching on Scopus database for published research concerning the association between quality of sleep and QoL (requiring in title the key-words: quality of sleep AND QoL), thousands of references are retrieved; but after removing clinical conditions, and

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after that particular situations or professional groups (eg, pregnancy; menopause women; elderly; shift workers; caregivers), the initial figures fall to dozens of studies. When further examining the abstracts to consider community/nonclinical samples comprising young adults with an emphasis on sleep quality (not just sleep duration or other sleep parameter) and QoL (not just well-being or satisfaction with life), we found only seven relevant results.[5–11] However, none of these seven studies were *controlled for* general psychological symptoms.

For example, Zeitlhofer et al.[10] studied an Austrian cohort ($N = 1049$) aged over 15 years and found a moderate correlation between quality of sleep and QoL. Chen et al.[8] studied a sample of 2391 US young adults and found that the overall and mental health-related QoL were associated with various sleep disturbances. Andruskiene et al.[5] observed that self-reported sleep disturbances contributed to a worse health-related QoL as measured by the SF-36 in a large study ($N = 1602$). Baldwin et al.[6] found that some sleep disturbances and health-related QoL are associated, but only studied people aged 40 years and older. Bower et al.[7] compared individuals with and without mood disorders and examined associations among sleep quality and positive and negative affect. Overall, sleep quality predicted positive affect. Other studies have focused on a sample of Israeli adolescents and reported several associations between sleep variables and QoL. However, this research focused on morningness and did not control for general psychological symptoms.[9] In a study comprising a large community sample ($N = 3225$) aged 18 to 55, Zhou et al.[11] found negative associations between sleep quality (measured by the PSQI) and QoL (SF-36) as expected—even when controlling for socio-demographic variables.

From all of these studies, we conclude that (i) the most common sleep quality metric was the PSQI; (ii) the QoL measure was variable and none of the studies used the WHOQOL-100 or WHOQOL-Bref; and (iii) the psychological symptoms were not consistently controlled.

Indeed, there are very few studies focused on healthy or non-clinical samples, and thus there is little knowledge on how the quality of sleep variations in these samples impact QoL. The few existing studies suggest a relationship between sleep quality and wellness, life satisfaction, or QoL even in samples comprising mostly healthy young adults (eg, college students[10,12,13]). These findings enhance the idea that the sleep may have significant impact on QoL even in the absence of sleep disorders or other health problems. This scenario is in accordance with the "sleep health" concept suggested by Buysse.[14]

Despite being mainly composed by healthy and young adults, many studies have shown that sleeping problems are quite common among college students.[15,16] For example, Wolfson[17] reported that 75% of college students have occasional sleep problems such as sleep-onset difficulties and excessive diurnal sleepiness. Also, delayed sleep phase syndrome is a frequent sleep problem in this population.[18] In a large study of university students, it was found that insomnia and insufficient sleep duration were the most common sleep problems.[19,20] A pattern characterized by poor sleep quality and a significant sleep restriction is common in college students, and various studies have suggested that poor quality of sleep is associated with a reduction in physical and psychological wellness.[12,13] Valdez, Ramirez and Garcia[21] posited that college students have an irregular sleep pattern characterized by the so-called "restriction-extension" sleep pattern. This is a reality consistent with the developmental tasks students face when transitioning to the university.[22,23] Some of these challenges pertain to alterations in students' social lives such as increased going out at night, leaving parents' home, reduction in parental control,[23] etc. These modifications may have a prominent role in inducing sleep disruption or sleep problems.

It is also known that psychological symptoms have an important role on self-reported QoL, and studies suggest that psychopathology might increase among college students for the past several years.[24,25] In a review by Hunt and Eisenberg,[26] it was observed that 17% of students reported depressive symptomatology, and 10% of them reported anxiety and stress-related symptomatology. In another study of 763 college students, more than a third had some kind of psychological problem.[27] Several factors can contribute to this scenario such as academic pressure, interpersonal problems, preoccupations about the future, and financial difficulties.[28] As expected, psychological disturbances can affect sleeping behavior; still, this association is bidirectional.[29,30]

In sum, given the importance of sleeping behavior in several domains of students' life, it is thus germane to examine whether sleep quality-related variables constitute independent predictors of QoL apart from psychological symptomatology. In summary, the purpose of our study was twofold: (i) to analyze the associations between subjective sleep quality and several dimensions of QoL in higher education students, and (ii) to examine whether or not sleep quality is a significant predictor of QoL after statistically controlling for psychopathological symptoms. This study refers to the frequently assumed conceptualization of sleep quality as a broad concept generally encompassing quantitative aspects such as sleep duration and latency, number of nocturnal awakenings, and more subjective topics including self-assessed sleep depth and quality.[31,32]

Method

Participants

We recruited 361 participants from the University of Aveiro (UA) both in the classroom context and across campus. Only cases with complete datasets were used, and only 324 cases were analyzed. Participants had a mean age of 20.89 years ($SD = 2.85$). The majority were female (65.7%) attending the 1st cycle of the university (66.7%) as full-time students (92.6%) after having left their parents' home to study at the university (65.1%) and now living in rented rooms in flats (59.6%). Most students reported that the places where they sleep have good conditions (good = 44.1% and very good = 41.0%). Furthermore, the majority did not identify sleep problems (88.6%) or mental health disturbances (95.7%).

Measures

Sociodemographic and clinical data

Sociodemographic and clinical data were collected through a section based on a previous questionnaire section used in earlier research in undergraduates.[20] This section encompassed questions on age, sex, number of enrollments in university, field of study, student status (i.e., ordinary, worker-student), whether the entry in university implied left parents' home, type of housing, the quality of the habitual sleep place, and whether the students self-identified a sleeping problem and/or a mental health problem. These data were only used to characterize the sample and were not used to perform inferential analyses.

Sleep quality

The Pittsburgh Sleep Quality Index (PSQI) was used to assess self-reported sleep quality over the last month[31]. The PSQI contains 19 items (0-3 Likert scale). Furthermore, the items clustered together form seven components (i.e., subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction). There were five additional questions such as whether the subject has a roommate, but these were not considered for quantitative scoring. The sum of the

seven components ranged from 0-21 and gives an overall score of sleep quality. Greater scores denote worse sleep quality. In this study, internal consistency values were acceptable/satisfactory ranging from $\alpha = .65$ (total seven components) to $\alpha = .74$ (considering the sixteen Likert-type items). We used the official PSQI European Portuguese Version by Mapi Institute—cf. psychometric characterization in Marques et al.[33]

Psychological symptoms

The brief symptom inventory (BSI) is a scale that evaluates generic psychological symptoms comprising 53 items.[34] The individuals rate the extent to which they have been disturbed (0 = not at all to 4 = extremely) in the past week by various symptoms. It comprises nine subscales: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobia, paranoia, and psychoticism. Moreover, it enables calculation of three indexes: global severity index, positive symptoms, and positive symptoms distress index. In our study, the Cronbach's alpha scores had minimum and maximum values of .68 (psychoticism) and .84 (depression), respectively. The Cronbach alpha for the total scale was .96. We used the official European Portuguese Version of the BSI[35].

Self-perceived QoL

The WHOQOL-Bref is a short form version of the WHOQOL-100 generic measure of self-perceived QoL that was developed by the World Health Organization (WHO).[36] It comprises 26 items that are organized in four domains: physical domain, psychological domain, social relationships domain, and environment domain. Furthermore, it is possible to calculate a general facet constituted by the sum of the two first items of the questionnaire. In our study, the internal consistency indexes ranged from $\alpha = .74$ (social relationships domain) to $\alpha = .78$ (psychological domain). We used the official WHOQOL-Bref European Portuguese Version.[37]

Procedure

This study followed the principles outlined in the Declaration of Helsinki, and we sought permission for all measures. We asked professors at the University of Aveiro to allow the students to complete the questionnaires during or after their classes. This increased the sample size. Other participants were identified across campus (eg, library). Before the participants completed the questionnaires, one of the researchers explained the purpose of the study and guaranteed anonymity of the collected data. They also explained that the participants could quit the study without any consequences at any time. Informed consent was then obtained. The estimated time for completing the entire protocol was 15-20 minutes. The order of the applied measures in the protocol was demographic data sheet, PSQI, WHOQOL-Bref, and BSI. Psychology undergraduate students who collaborated in this study were given partial credit for completing the questionnaires. Data were collected in the first academic semester outside of the examination period.

Statistical analysis

All calculations were performed using IBM SPSS Statistics (version 19.0). First, we computed descriptive statistics such as relative and absolute frequencies, means, and standard deviations to characterize the sample. The Pearson product-moment correlation coefficients were measured to explore the associations among sleep quality, psychological symptoms and QoL variables. Then, considering variables significantly associated with QoL, we carried out four hierarchical multiple regression analyses with two steps in each. In step 1, psychopathology-related measures were entered; in step 2, sleep-related variables were entered in a different block. Hierarchical regression analyses aimed to clarify whether sleep quality variables would remain associated with QoL after controlling for the influence of psychopathology. Hierarchical linear regression is a statistical technique that allows the researcher to constitute blocks of variables that will serve as covariates for those entered later. Consequently, one may examine the unique contributions of the variables of interest independent from the other related variables.[38] A significance value of $P < .05$ was considered for all analyses.

Results

Descriptive analysis

Table 1 displays the mean scores for all the variables considered in our study. The mean score of the total PSQI was 5.25, and the component scores ranged between 0.1 (sleep efficiency) and 1.16 (daytime dysfunction). The mean overall score was similar—albeit systematically lower compared to other studies of university students ([16,39–44]). Regarding the WHOQOL-Bref results, we found that the domains' means raged between 67.12 (environment domain) and 74.61 (physical domain). The mean score of the general facet of the WHOQOL-Bref was 73.23. We found that the WHOQOL-Bref mean scores were higher for our sample in psychological and environmental domains compared to the normative Portuguese data. The scores in the remaining domains were lower for our sample. However, we note that the age range of our group was not as broad as the normative group, and this might account for this difference.[37] Finally, BSI mean scores ranged between 0.38 (phobic anxiety) and obsessive-compulsive (1.11). The global severity index mean score was 0.61. The BSI scores of our sample are lower than the normative scores of a non-clinical Portuguese

Table 1

Descriptive statistics concerning sleep quality, quality of life and psychopathological symptoms scores

	Total sample (N = 324)	
	M (SD)	Min-Max
PSQI (C1)	1.01 (0.57)	0-3
PSQI (C2)	1.02 (0.87)	0-3
PSQI (C3)	0.74 (0.76)	0-3
PSQI (C4)	0.10 (0.36)	0-3
PSQI (C5)	1.09 (0.46)	0-3
PSQI (C6)	0.14 (0.49)	0-3
PSQI (C7)	1.16 (0.72)	0-3
PSQI (total)	5.25 (2.51)	0-17
WHOQOL-Bref (D1)	73.23 (12.85)	25-100
WHOQOL-Bref (D2)	74.61 (12.81)	32.1-100
WHOQOL-Bref (D3)	69.16 (13.57)	29.2-100
WHOQOL-Bref (D4)	73.01 (14.83)	25-100
WHOQOL-Bref	67.12 (11.26)	25-96.9
BSI somatization	0.43 (0.49)	0-2.1
BSI obsessive-compulsive	1.11 (0.69)	0-3.3
BSI interpersonal sensitivity	0.68 (0.64)	0-3.8
BSI depression	0.78 (0.66)	0-3.7
BSI anxiety	0.72 (0.62)	0-3.0
BSI hostility	0.81 (0.64)	0-3.2
BSI phobia	0.38 (0.52)	0-3.2
BSI paranoia	0.84 (0.64)	0-2.8
BSI psychoticism	0.57 (0.56)	0-2.6
BSI global severity index	0.61 (0.49)	0-2.4
BSI positive symptoms	24.23 (12.86)	1-52
BSI positive symptoms distress index	1.42 (0.37)	1-3

Note. M = Mean; SD = Standard Deviation; PSQI (C1) = subjective sleep quality; PSQI (C2) = sleep latency; PSQI (C3) = sleep duration; PSQI (C4) = habitual sleep efficiency; PSQI (C5) = sleep disturbances; PSQI (C6) = use of sleeping medication; PSQI (C7) = daytime dysfunction; PSQI (total) = PSQI total score; WHOQOL-Bref (D1) = physical; WHOQOL-Bref (D2) = psychological; WHOQOL-Bref (D3) = social relationships; WHOQOL-Bref (D4) = environment; WHOQOL-Bref = general facet.

	WHOQOL-Bref	WHOQOL-Bref (D1)	WHOQOL-Bref (D2)	WHOQOL-Bref (D3)	WHOQOL-Bref (D4)
PSQI (C1)	−0.367[**]	−0.546[**]	−0.446[**]	−0.190[*]	−0.307[**]
PSQI (C2)	−0.168[*]	−0.312[**]	−0.307[**]	n.s.	n.s.
PSQI (C3)	−0.140[*]	−0.217[**]	−0.151[*]	n.s.	−0.133[*]
PSQI (C4)	−0.120[*]	−0.141[*]	−0.136[*]	n.s.	n.s.
PSQI (C5)	−0.291[**]	−0.333[**]	−0.328[**]	n.s.	−0.212[**]
PSQI (C6)	−0.181[*]	−0.329[**]	−0.312[**]	n.s.	n.s.
PSQI (C7)	−0.249[**]	−0.370[**]	−0.379[**]	−0.164[*]	−0.164[*]
PSQI (total)	−0.362[**]	−0.551[**]	−0.504[**]	−0.170[*]	−0.256[**]
BSI somatization	−0.348[**]	−0.524[**]	−0.414[**]	n.s.	−0.374[**]
BSI obsessive-compulsive	−0.274[**]	−0.607[**]	−0.614[**]	−0.250[**]	−0.349[**]
BSI interpersonal sensitivity	−0.293[**]	−0.435[**]	−0.516[**]	−0.278[**]	−0.326[**]
BSI depression	−0.353[**]	−0.542[**]	−0.648[**]	−0.334[**]	−0.359[**]
BSI anxiety	−0.299[**]	−0.539[**]	−0.526[**]	−0.142[*]	−0.346[**]
BSI hostility	−0.286[**]	−0.469[**]	−0.462[**]	−0.202[**]	−0.348[**]
BSI phobia	−0.228[**]	−0.356[**]	−0.321[**]	−0.145[*]	−0.303[**]
BSI paranoia	−0.290[**]	−0.402[**]	−0.456[**]	−0.283[**]	−0.363[**]
BSI psychoticism	−0.308[**]	−0.487[**]	−0.560[**]	−0.319[**]	−0.341[**]

population. This might be because of the broader age range in the normative sample.[35]

Correlational analysis

In terms of the association between QoL and quality of sleep, we found that the general, physical, and psychological domains exhibited significant negative correlations ($P < .05$) with all PSQI components and the PSQI total score (cf. Table 2). On the other hand, the domain of social relations only showed significant negative correlations with the subjective quality of sleep, daytime dysfunction, and total PSQI. The environmental domain showed significant and inverse correlations with subjective quality of sleep, sleep duration, sleep disturbances, daytime dysfunction and total PSQI.

As for the relationship between QoL and psychopathological symptoms, all areas of the WHOQOL-Bref—except for the social relationships domain—show significant negative correlations with all BSI dimensions (cf. Table 2). Note that the association between the social relationships domain and somatization was the only correlation that was not statistically significant ($P > .05$).

Regarding the relationship between quality of sleep and psychopathological symptoms, we found that the components of subjective sleep quality, sleep disturbances, use of sleeping medication and daytime dysfunction showed significant positive correlations with all BSI dimensions. However, components related to sleep latency, sleep duration and habitual sleep efficiency showed no significant relationships with psychopathological dimensions (see Table 3).

Hierarchical multiple regression analysis

Next, we performed hierarchical multiple linear regression analyses to examine sleep quality as a potential predictor of QoL while controlling for psychopathological symptoms. Based on the correlational analyses performed previously, we entered only the variables that presented statistically significant correlations (see correlational analyses section).

Considering the general facet of the WHOQOL-Bref, we found that both psychopathology and sleep quality contributed significantly to general QoL accounting for 24% of the explained variance. While controlling for psychological symptoms, the sleep quality block still adds a significant contribution to the general QoL of about 8% (see Table 4). It is important to note that despite these results, only three

components significantly contributed to general QoL—specifically somatization ($\beta = -0.20$; $P < .05$), depression ($\beta = -0.21$; $P < .05$), and subjective sleep quality ($\beta = -0.24$; $P < .001$). Considering the analysis of standardized regression coefficients (β), the subjective quality of sleep best accounted for the variance in the general QoL.

As to the physical domain of WHOQOL-Bref, we found that psychological symptoms, and sleep quality blocks also contributed significantly explaining about 54% of the total variance (cf. Table 5). Controlling for psychopathological symptoms, the sleep quality block accounted for 11% of the observed results in the physical domain of QoL. In addition to somatization ($\beta = -.20$; $P < .01$) and subjective sleep quality ($\beta = -0.03$, $P < .001$), the obsessive-compulsive dimension was also a significant predictor of the physical domain of QoL ($\beta = 0.10$; $P < .001$). We again found that subjective sleep quality was the component with the most weight in the model.

When considering the psychological domain of the WHOQOL-Bref as a criterion, we observed that both blocks were significant and explained about 54% of the variance. Sleep quality yet again had a significant and unique contribution (6%) in addition to psychopathological symptoms (see Table 6). The obsessive-compulsive ($\beta = -0.23$; $P < .01$) and depression dimensions ($\beta = -0.36$; $P < .001$) and subjective sleep quality ($\beta = -0.20$; $P < .001$) significantly contributed to the psychological domain of QoL. In this case, depression had the most weight in the model.

The results of hierarchical regression using the social relationship domain of the WHOQOL-Bref as criterion variable are shown in Table 7. In contrast to previous analyses, we found that sleep quality did not significantly predict QoL. Thus, none of the entered sleep-related variables (i.e., subjective sleep quality and daytime dysfunction) added a significant contribution to the model. Depression ($\beta = -0.27$; $P < .05$) and anxiety ($\beta = 0.32$; $P < .01$) were the only significant components of the BSI.

Regarding the environmental domain of the QoL, the results indicated that psychological symptoms and sleep quality explained a significant 23% of the environmental domain of WHOQOL-Bref (cf. Table 8). Three variables contributed significantly to the environmental domain of the QoL namely somatization ($\beta = -0.17$; $P < .05$), paranoia ($\beta = -0.17$; $P < .05$) and subjective sleep quality ($\beta = -0.17$; $P < .01$). Subjective sleep quality was the only PSQI component which added a significant contribution (3%) to this domain of QoL regardless of psychopathological symptoms.

Table 3

Correlation matrix between sleep quality and psychological symptoms variables

	BSI somatization	BSI obsessive-compulsive	BSI interpersonal sensitivity	BSI depression	BSI anxiety	BSI hostility	BSI phobia	BSI paranoia	BSI psychoticism
PSQI (C1)	0.311**	0.331**	0.264**	0.330**	0.313**	0.300**	0.203**	0.224**	0.272**
PSQI (C2)	0.196**	0.279**	0.137*	0.205**	0.208**	0.227**	n.s.	n.s.	0.179*
PSQI (C3)	0.116*	0.125*	0.152*	0.168*	0.153*	0.142*	n.s.	0.128*	0.152*
PSQI (C4)	n.s.	n.s.	0.122*	n.s.	n.s.	0.138*	0.111*	n.s.	n.s.
PSQI (C5)	0.394**	0.353**	0.300**	0.321**	0.387**	0.349**	0.269**	0.282**	0.346**
PSQI (C6)	0.295**	0.307**	0.145**	0.251**	0.292**	0.181*	0.211**	0.127*	0.228**
PSQI (C7)	0.337**	0.452**	0.298**	0.414**	0.365**	0.371**	0.225**	0.288**	0.365**

*$P < .05$; **$P < .001$; n.s. = not significant.

Note. PSQI (C1) = subjective sleep quality, PSQI (C2) = sleep latency, PSQI (C3) = sleep duration, PSQI (C4) = habitual sleep efficiency, PSQI (C5) = sleep disturbances, PSQI (C6) = use of sleeping medication, PSQI (C7) = daytime dysfunction.

Discussion

In this study, we examined the association between sleep quality and QoL while controlling for the effect of psychological symptomatology in a non-clinical sample. According to the literature, sleep problems can affect many areas of life and be associated with several health problems.[44,45]

This study agrees with other studies that have observed correlations between sleep quality measures and self-reported QoL measures (eg,[5–11]). Furthermore, our results suggest that the QoL of college students may be significantly predicted by their quality of sleep even when psychopathology indicators are statistically controlled. Only the social relationships domain of QoL is not significantly predicted by sleep quality. These findings concur with Pilcher et al.[13] and Buboltz et al.[12] who reported that poor sleep quality is associated with a significant reduction in the physical and psychological well-being. Other studies have verified that college students exhibited better scores in QoL or QoL-related measures when they had a good night of sleep.[46,47] Zeitlhofer et al.[10] found a moderate and significant association between sleep quality and QoL. However, unlike our study, none of these studies controlled for psychological symptoms; thus, those studies could not rule out the possibility that the association between sleep quality and QoL could be explained by psychopathology. Therefore, our results contribute to knowledge about the associations between sleep quality and QoL. The results suggest that sleep quality adds an independent and significant contribution to QoL beyond psychopathological symptoms.

We found that college students have a mean sleep quality near the threshold for poor sleep according to the PSQI cut-off point >5[31] with increased scores in daytime dysfunction component. Similar or even higher mean scores (indicating poorer sleep quality) have been reported in college samples from other countries.[16,39–44] The present results also concur with other studies on sleep habits in Portuguese college students using different self-report instruments.[19,48]

The entry into higher education may not only cause changes in sleep quality but also in the QoL of students. Ducinskiene et al.[49] found that the physical health domain of the students' QoL improved while they remained in college. Our results support this finding

Table 4

Summary of a hierarchical regression analysis predicting general facet of QoL

	B	SE	β	t	p	R^2	ΔR^2	ΔF	$p \Delta F$
Step 1a						0.165	0.165	6.908	0.000
Somatization	−7.219	2.158	−.273	−3.346	**.001**				
Obsessive-compulsive	.571	1.545	.031	.370	.712				
Interpersonal sensitivity	.085	1.738	.004	.049	.961				
Depression	−5.178	2.007	−.268	−2.580	**.010**				
Anxiety	1.182	2.090	.057	.566	.572				
Hostility	.021	1.593	.001	.013	.989				
Phobic anxiety	1.488	1.858	.060	.801	.424				
Paranoia	−1.990	1.576	−.100	−1.262	.208				
Psychoticism	.944	2.270	.041	.416	.678				
Step 2b						0.241	0.075	4.359	0.000
Somatization	−5.338	2.124	−.202	−2.514	**.012**				
Obsessive-compulsive	1.865	1.580	.101	1.180	.239				
Interpersonal sensitivity	.092	1.696	.005	.054	.957				
Depression	−4.076	1.967	−.211	−2.072	**.039**				
Anxiety	1.282	2.042	.061	.628	.531				
Hostility	.697	1.563	.035	.446	.656				
Phobic anxiety	1.134	1.836	.046	.618	.537				
Paranoia	−2.279	1.551	−.114	−1.469	.143				
Psychoticism	.737	2.201	.032	.335	.738				
PSQI (C1)	−5.292	1.361	−.235	−3.887	**.000**				
PSQI (C2)	.112	.856	.008	.130	.896				
PSQI (C3)	.091	.959	.005	.095	.924				
PSQI (C4)	−.971	1.884	−.028	−.515	.607				
PSQI (C5)	−3.066	1.623	−.110	−1.890	.060				
PSQI (C6)	−.036	1.491	−.001	−.024	.981				
PSQI (C7)	−1.472	1.047	−.083	−1.405	.161				

B = unstandardized beta coefficient; SE = standard error; $β$ = standardized beta coefficient; ΔR^2 = R^2 Change; ΔF = F Change; $p \Delta F$ = Sig. F Change.

[a] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia, somatization, interpersonal sensitivity, anxiety, depression.

[b] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia, somatization, interpersonal sensitivity, anxiety, depression, PSQI (C1) = subjective sleep quality, PSQI (C2) = sleep latency, PSQI (C3) = sleep duration, PSQI (C4) = habitual sleep efficiency, PSQI (C5) = sleep disturbances, PSQI (C6) = use of sleeping medication, PSQI (C7) = daytime dysfunction.

Table 5
Summary of a hierarchical regression analysis predicting physical QoL domain (D1)

	B	SE	β	t	p	R^2	ΔR^2	ΔF	$p \Delta F$
Step 1a						0.433	0.433	26.646	0.000
Somatization	−6.628	1.772	−.252	−3.740	**.000**				
Obsessive-compulsive	−7.016	1.269	−.380	−5.529	**.000**				
Interpersonal sensitivity	.494	1.427	.025	.346	.730				
Depression	−4.182	1.648	−.217	−2.537	**.012**				
Anxiety	−.408	1.716	−.020	−.238	.812				
Hostility	−.007	1.308	.000	−.005	.996				
Phobic anxiety	1.017	1.525	.041	.667	.506				
Paranoia	.881	1.295	.044	.681	.496				
Psychoticism	.710	1.864	.031	.381	.704				
Step 2b						0.541	0.108	10.328	0.000
Somatization	−4.867	1.645	−.202	−2.958	**.003**				
Obsessive-compulsive	−5.695	1.224	.101	−4.652	**.000**				
Interpersonal sensitivity	.472	1.314	.005	.359	.720				
Depression	−2.680	1.524	−.211	−1.759	.080				
Anxiety	−.389	1.582	−.185	−.246	.806				
Hostility	.494	1.211	−.309	.408	.684				
Phobic anxiety	.597	1.422	.024	.420	.675				
Paranoia	.412	1.202	−.139	.343	.732				
Psychoticism	.164	1.705	−.019	.096	.923				
PSQI (C1)	−7.311	1.055	.025	−6.932	**.000**				
PSQI (C2)	−.162	.663	.024	−.245	.807				
PSQI (C3)	−.329	.743	.021	−.443	.658				
PSQI (C4)	−.853	1.459	.007	−.585	.559				
PSQI (C5)	.097	1.257	−.325	.077	.939				
PSQI (C6)	−.974	1.155	−.011	−.843	.400				
PSQI (C7)	−.648	.811	−.019	−.799	.425				

B = unstandardized beta coefficient; SE = standard error; β = standardized beta coefficient; ΔR^2 = R^2 Change; ΔF = F Change; $p \Delta F$ = Sig. F Change.
[a] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia, somatization, interpersonal sensitivity, anxiety, depression.
[b] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia, somatization, interpersonal sensitivity, anxiety, depression, PSQI (C1) = subjective sleep quality, PSQI (C2) = sleep latency, PSQI (C3) = sleep duration, PSQI (C4) = habitual sleep efficiency, PSQI (C5) = sleep disturbances, PSQI (C6) = use of sleeping medication, PSQI (C7) = daytime dysfunction.

Table 6
Summary of a hierarchical regression analysis predicting psychological QoL domain (D2)

	B	SE	β	t	p	R^2	ΔR^2	ΔF	$p \Delta F$
Step 1a						0.480	0.480	32.262	0.000
Somatization	−.638	1.798	−.023	−.355	.723				
Obsessive-compulsive	−6.320	1.288	−.323	−4.908	**.000**				
Interpersonal sensitivity	−1.164	1.448	−.055	−.804	.422				
Depression	−8.625	1.672	−.422	−5.157	**.000**				
Anxiety	−.324	1.741	−.015	−.186	.852				
Hostility	1.352	1.327	.064	1.018	.309				
Phobic anxiety	2.157	1.548	.083	1.394	.164				
Paranoia	.405	1.314	.019	.308	.758				
Psychoticism	−1.191	1.892	−.049	−.629	.530				
Step 2b						0.543	0.062	5.958	0.000
Somatization	.994	1.741	.036	.571	.568				
Obsessive-compulsive	−4.508	1.295	−.231	−3.480	**.001**				
Interpersonal sensitivity	−1.463	1.390	−.069	−1.053	.293				
Depression	−7.399	1.612	−.362	−4.589	**.000**				
Anxiety	−.566	1.674	−.026	−.338	.736				
Hostility	1.897	1.281	.090	1.480	.140				
Phobic anxiety	2.341	1.505	.090	1.555	.121				
Paranoia	−.411	1.272	−.019	−.323	.747				
Psychoticism	−1.534	1.804	−.063	−.850	.396				
PSQI (C1)	−4.741	1.116	−.199	−4.248	**.000**				
PSQI (C2)	−1.013	.702	−.065	−1.444	.150				
PSQI (C3)	1.099	.787	.061	1.398	.163				
PSQI (C4)	−1.350	1.544	−.036	−.874	.383				
PSQI (C5)	−.645	1.330	−.022	−.485	.628				
PSQI (C6)	−1.793	1.222	−.065	−1.467	.143				
PSQI (C7)	−1.281	.859	−.068	−1.492	.137				

B = unstandardized beta coefficient; SE = standard error; β = standardized beta coefficient; ΔR^2 = R^2 Change; ΔF = F Change; $p \Delta F$ = Sig. F Change.
[a] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia, somatization, interpersonal sensitivity, anxiety, depression.
[b] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia, somatization, interpersonal sensitivity, anxiety, depression, PSQI (C1) = subjective sleep quality, PSQI (C2) = sleep latency, PSQI (C3) = sleep duration, PSQI (C4) = habitual sleep efficiency, PSQI (C5) = sleep disturbances, PSQI (C6) = use of sleeping medication, PSQI (C7) = daytime dysfunction.

Table 7

Summary of a hierarchical regression analysis predicting social relationships QoL domain (D3)

	B	SE	β	t	p	R^2	ΔR^2	ΔF	$p\ \Delta F$
Step 1a						0.162	0.162	7.624	0.000
Obsessive-compulsive	−2.151	1.776	−.101	−1.211	.227				
Interpersonal sensitivity	−1.221	2.005	−.053	−.609	.543				
Depression	−6.517	2.304	−.292	−2.828	**.005**				
Anxiety	7.490	2.290	.311	3.272	**.001**				
Hostility	.871	1.815	.038	.480	.632				
Phobic anxiety	−.152	2.045	−.005	−.074	.941				
Paranoia	−2.266	1.819	−.098	−1.246	.214				
Psychoticism	−3.995	2.610	−.150	−1.531	.127				
Step 2b						0.172	0.010	1.905	0.151
Obsessive-compulsive	−1.622	1.822	−.076	−.890	.374				
Interpersonal sensitivity	−1.223	2.002	−.053	−.611	.542				
Depression	−6.021	2.321	−.270	−2.594	**.010**				
Anxiety	7.649	2.285	.317	3.348	**.001**				
Hostility	1.142	1.818	.049	.628	.530				
Phobic anxiety	−.147	2.039	−.005	−.072	.943				
Paranoia	−2.402	1.816	−.104	−1.323	.187				
Psychoticism	−4.150	2.604	−.156	−1.594	.112				
PSQI (C1)	−2.703	1.447	−.104	−1.867	.063				
PSQI (C7)	−.467	1.214	−.023	−.385	.701				

B = unstandardized beta coefficient; SE = standard error; $β$ = standardized beta coefficient; ΔR^2 = R^2 Change; ΔF = F Change; $p\ \Delta F$ = Sig. F Change.

[a] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia, interpersonal sensitivity, anxiety, depression.

[b] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia,, interpersonal sensitivity, anxiety, depression, PSQI (C1) = subjective sleep quality, PSQI (C7) = daytime dysfunction.

because the participants reported that this domain contributes most to their QoL.[50]

This study also assessed the psychological symptomatology of students because this seems to be increasing in both the frequency and intensity in this population.[25,26] According to Hunt and Eisenberg,[26] college students have elevated scores on measures of depression and anxiety. According to Storrie et al.,[51] about 47% of young people reported suffering from mental health problems. The results we found through BSI are in accordance with this trend. Our participants scored higher in obsessive-compulsive symptoms, paranoia and hostility.

In general, our results are similar to the literature and suggest that poor sleep quality in college students is associated with a decrease in variables related to QoL. This is the case in the physical or psychological health domains.[12,13,19,44,46,47] However, to the best of our knowledge, no study has yet evaluated the relationship between the sleep quality and the QoL using a WHOQOL instrument on young healthy adults.

Table 8

Summary of a hierarchical regression analysis predicting environment QoL domain (D4).

	B	SE	β	t	p	R^2	ΔR^2	ΔF	$p\ \Delta F$
Step 1a						0.197	0.197	8.574	0.000
Somatization	−4.433	1.854	−.192	−2.392	**.017**				
Obsessive-compulsive	−1.333	1.327	−.082	−1.004	.316				
Interpersonal sensitivity	.354	1.493	.020	.237	.813				
Depression	−2.091	1.724	−.123	−1.213	.226				
Anxiety	1.146	1.795	.063	.639	.524				
Hostility	−1.185	1.369	−.067	−.866	.387				
Phobic anxiety	−1.232	1.596	−.057	−.772	.441				
Paranoia	−2.906	1.354	−.166	−2.146	**.033**				
Psychoticism	1.199	1.950	.059	.615	.539				
Step 2b						0.228	0.030	0.3051	0.017
Somatization	−3.820	1.860	−.165	−2.053	**.041**				
Obsessive-compulsive	−1.247	1.356	−.077	−.919	.359				
Interpersonal sensitivity	.528	1.479	.030	.357	.721				
Depression	−1.721	1.726	−.102	−.998	.319				
Anxiety	1.355	1.785	.074	.759	.448				
Hostility	−1.049	1.356	−.060	−.774	.440				
Phobic anxiety	−1.607	1.604	−.074	−1.002	.317				
Paranoia	−2.970	1.339	−.170	−2.218	**.027**				
Psychoticism	.999	1.934	.049	.517	.606				
PSQI (C1)	−3.319	1.135	−.168	−2.926	**.004**				
PSQI (C3)	−.689	.819	−.046	−.841	.401				
PSQI (C5)	−.222	1.385	−.009	−.161	.873				
PSQI (C7)	.920	.920	.059	1.000	.318				

B = unstandardized beta coefficient; SE = standard error; $β$ = standardized beta coefficient; ΔR^2 = R^2 Change; ΔF = F Change; $p\ \Delta F$ = Sig. F Change.

[a] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia, somatization, interpersonal sensitivity, anxiety, depression.

[b] Predictors: (constant), psychoticism, phobia, obsessive-compulsive, hostility, paranoia, somatization, interpersonal sensitivity, anxiety, depression, PSQI (C1) = subjective sleep quality, PSQI (C3) = sleep duration, PSQI (C5) = sleep disturbances, PSQI (C7) = daytime dysfunction.

One important finding of our study is that the subjective quality of sleep seems to be the PSQI component that contributes most to QoL (except in the social relationships domain). In addition, our results show that, at least in college students, the potential impact of sleep quality on QoL is not attributable to the influence of psychopathological symptoms, i.e., sleep quality is a unique predictor of QoL regardless of psychopathological symptoms. We believe that this result highlights the potential role of sleep quality per se in QoL even in a sample composed of mostly healthy and successful young adults.

Despite these interesting results, we acknowledge some limitations: the inclusion criteria for participating in the study were very broad, and our sample was non-probabilistic. This is an observational study, and therefore no causal relationship may be inferred. Furthermore, we did not control/evaluate whether the participants were taking medication that might interfere with sleep patterns or improve it. In addition, the translation of PSQI we used was not performed by Portuguese researchers (albeit the one we used is an official European Portuguese version). Despite these limitations, this study has many strong points due to the sample size and the use of widely accepted instruments to evaluate the variables. In order to minimize some of these limitations, we proposed to use objective measures of sleep such as actimetry as a complement to self-report instruments. It would also be very interesting to examine a large group of college students at different points in their academic path as longitudinal research. This could measure the stability of the findings.

In summary, we found that the QoL of college students is predicted by the quality of sleep even when indicators of psychopathology are controlled. More specifically, sleep quality can predict all domains of the self-reported QoL (except one). This was the only sleep component of the PQSI that remains a significant predictor regardless of psychopathological symptoms. The other components in the PSQI lost significance. Finally, in terms of implications, and in the same line as Buboltz et al.,[12] our results encourage the creation of sleep psychology consultations in college settings as well as sleep education interventions/programs to improve sleep quality—even in individuals without sleep disorders. This could contribute to so-called "sleep health".[14]

Conflicts of interest

None of the authors declares conflict of interest.

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