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ORIGINAL ARTICLE

The Relationship Between Subjective Sleep Quality and Smoking in University Students

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ABSTRACT
In a sample of 444 university students, the subjective quality of sleep was analyzed and compared between smokers and non-smokers. Nicotine dependence was assessed using the Fagerström Test for Nicotine Dependence and the subjective quality of sleep was measured using the Pittsburgh Sleep Quality Index. Of the sample, 41.2% admitted to smoking daily. Poor sleep quality was reported by 45.7% of the sample (scores of > 5 on the PSQI). Smokers presented a risk of poor sleep quality that was greater than that of non-smokers with an *Odds Ratio (OR)* = 1.42 (95% CI [.990-2.074]). Smokers appear to have an increased risk of long sleep latencies with an *OR* = 1.50 (95% CI [1.018-2.213]). Moreover, smokers have a greater risk of showing high sleep disturbance with an *OR* = 2.45 (95% CI [1.391-4.304]). It is necessary to extend the studies that link sleep with cigarette smoking, and to explore the factors that modulate these causal relationships.
Keywords: Dependence, Tobacco, Insomnia, Sleep, University students.

Introduction

The university student population usually shows a risk for the consumption of tobacco with certain prevalence rates of use-abuse that are worth noting (Alexopoulos, Jelastopulu, Aronis, & Dougenis, 2009; Bakar, Gündogar, Ozisik, & Maral, 2013; Sreeramareddy, Ramakrishnareddy, Rahman, & Mir, 2018). For instance, it has been reported that 45.7% of university students had used a tobacco product in the last year and 32.9% used tobacco at the present time (Rigoti, Lee, & Wechsler, 2000). Cigarettes accounted for most of this consumption, with a prevalence of 28.5%, but tobacco consumption was also considerable throughout the whole lifespan (Rigoti et al., 2000) accounting for 37.1% of the sample. In addition, Tran et al. (2017) reported that during the 30 days preceding the evaluation, 6.3% were frequent-to-heavy tobacco smokers. In this context, it has been indicated that 45% of university students find it difficult to avoid smoke from cigarettes consumed by other students (second-hand smoke) when they are outdoors on campus (Fallin, Roditis, & Glantz, 2015).

Along with the health problems associated with the consumption of tobacco in the university population, it has also been observed that this group usually presents sleep problems. More than 60% of the university population have reported a sleep problem (Lund, Reider, Whiting, & Prichard, 2010)

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with more than 25% sleeping less than 7 hours per night, as shown by measures of poor sleep quality (Quick et al., 2016). Between 16% and 23% of university students report symptoms of insomnia (Bixler, Vgontzas, Lin, Vela-Bueno, & Kales, 2002; Cukrowicz et al., 2006; Haji Seyed Javadi, & Shafikhani, 2019; Hardison, Neimeyer, & Lichstein, 2005), significant mental health problems related to sleep disorders (Taylor et al. 2011) and direct effects on academic performance (Gomes, Tavares, & Azevedo, 2011). However, relatively few studies have focused on the links between smoking, nicotine dependence, and sleep difficulties. It is assumed that nicotine dependence is a function of the degree of intake, which can be measured by the number of cigarettes smoked. Thus, nicotine dependence has been operationalized in terms of cigarette consumption (Fagerstrom, 1978; Fagerström & Schneider, 1989).

In the first study to examine the relationship between sleep quality and indicators of smoking behavior and nicotine dependence (Cohrs et al., 2014), an association was found between smoking and longer sleep latency, shorter sleep duration, and poorer overall sleep quality in adults aged 18 to 65 years. These authors also reported that the most severe symptoms of nicotine dependence and daily cigarette smoking are associated with shorter sleep duration (Cohrs et al., 2014).

Smokers also report that their quality of sleep is poorer when a greater quantity of tobacco is consumed, with a longer duration of superficial sleep (Zhang, Samet, Caffo, Bankman, & Punjabi, 2008). A dose-response relationship was observed between the quantity smoked and the symptoms of disrupted sleep (Mehari, Weir, & Gillum, 2014). According to cohort studies carried out in adolescents, smoking could be a predictor of difficulties in both falling sleep and maintaining sleep, and, consequently the quality of sleep (Patten, Choi, Gillin, & Pierce, 2000). Furthermore, the frequency of exposure to second-hand smoke has been positively correlated with a shorter duration of sleep and a greater frequency of restless sleep (Morioka et al., 2018; Schwartz, Bottorff, & Richardson, 2014).

In a community of Spanish university students, 37.7% have been reported to smoke (Molina et al., 2012), which is a greater percentage than that indicated by Hernández-Serrano, Font-Mayolas, & Eugènia-Gras (2015), who found that, in a sample of 478 university students, 17.4% admitted to being cigarette smokers. However, with a sample of 4381 university students, Martínez et al. (2019) found that 29.7% reported being smokers, a prevalence that is similar to the 25.9% reported by Álvarez-Pérez et al. (2017) among Education students, but considerably higher than the 16.7% of smokers reported among students of Health-related subjects.

Among first-year university students, it was observed that 17.3% reported smoking tobacco daily whilst 13.5% reported smoking occasionally. The prevalence of smoking was higher among women (33%) than men (27%), with no gender differences in terms of the number of cigarettes smoked per day (Jiménez-Muro, Beamonte, Marqueta, Gargallo, & Nerín, 2009). These data are partially supported by the findings of Escario and Wilkinson (2018) who found that overall, 16.6% of students reported smoking daily in the past month. Smoking was more prevalent among females (17.9%) than males (15.4%), but among the smokers males smoke more cigarettes (6.39) than females (6.10) on average. However, not all studies provide support for these gender differences, since Ranchal-Sánchez, Pérula-De Torres, Santos-Luna and Ruiz-Moral (2018) found a prevalence of smoking of 6.5%, with no significant differences according to gender. A study conducted by Hernández-Serrano et al. (2015) also failed to find such gender differences (men: 17.8%, and women: 16.9%). These observations run counter to those reported in other countries, where it has been shown that 24.9% of male university students are smokers compared with 16.6% of female students (Sun, Buys, Stewart, Shum, & Farquhar, 2011).

Therefore, given the absence of previous studies that analyze the relationship between smoking and sleep quality, both in the adult and young population and specifically in the Spanish university population, the aim of the present study was to compare the subjective perception of sleep quality between smokers and non-smokers in a population of Spanish university students. Similarly, we aimed

to identify whether the degree of dependence on nicotine is related to the perceived quality of sleep and to explore any possible differences in sleep quality according to gender.

Based on our review of the literature, it is expected that university students who smoke cigarettes regularly will show a poorer quality of sleep in comparison with non-smokers. Similarly, those smokers who show the highest scores on nicotine dependence will report a poorer quality of sleep compared with those who indicate a moderate or low level of dependency. Finally, it is anticipated that females who smoke regularly will report a greater number of sleep problems and poorer sleep quality in comparison with their male counterparts.

Method

Participants

A total of 444 caucasian university students participated in the study, of which 195 (43.9%) were men (56.1% women) (see Table 1). The mean age of the sample was 22.38 years (*Min* = 19, *Max* = 26) with a *SD* = 2.131, with the men having an average age of 22.52 years (*SD* = 2.094) and the women an average age of 22.27 years (*SD* = 2.158). A Student's *t* test for independent samples revealed no differences (t = 1.202, p = .20) between men and women for age. Of the sample, 0.5% reported being married and 99.5% were single. As expected, the men were taller and weighed more than women, whilst also showing a higher Body Mass Index (BMI), whilst more women were categorized as underweight.

In our sample, 41.2% (n = 183) reported smoking daily, with 45.36% (n = 83) of the smokers being men. In addition, 40.2% of all women in the sample reported to be smokers compared with 42.6% of men. No differences were observed in smoking status as a function of gender ($\chi^2_{(1,444)}$ = .261, p = .610). In addition, no differences were observed between smokers (M = 22.79, SD = 3.257) and non-smokers (M = 22.98, SD = 3.071) with respect to BMI (t = 1.332, p = .183).

Instruments

A brief ad hoc interview was conducted to gather data on socio-demographic variables (gender, year of birth, weight, height and marital status, and substances use). In order to assess nicotine dependence, the Fagerström Test for Nicotine Dependence (FTND) (Fagerström & Schneider, 1989) was employed in its Spanish version (Becoña, Gómez-Durán, Álvarez-Soto, & García, 1992). This survey evaluates the level of physical addiction to nicotine in a smoker based on the consumption of cigarettes. Specifically, the instrument measures the number of cigarettes consumed, along with compulsive smoking and the degree of dependence on cigarettes. Each of the six items is scored from 0 to 3 or from 0 to 1, and by summing all of its components a final score is obtained that ranges from 0 to 10. A higher score is taken to indicate greater physical dependence on nicotine (0-4= low nicotine dependence; 5-6 = moderate dependence on nicotine; 7-10 = high dependence on nicotine). The original internal consistency (Fagerström & Schneider, 1989) of the test is .56 to .64. In the present study the FTND test showed acceptable reliability (α = .726).

Table 1: General characteristics of the sample of university students

	Total	**Men**	**Women**			
	444	N=195 (43.92%)	N=249 (56.08%)			
	M (SD)	*M (SD)*	*M (SD)*	*t*	*p*	*Cohen's d*
Height	169.40 (9.370)	176.87 (7.451)	163.55 (5.937)	20.390	< .001	1.98
Weight	65.12 (12.791)	74.49 (11.109)	57.78 (8.522)	17.934	< .001	1.69
BMI	22.55 (3.152)	23.78 (3.063)	21.59 (2.876)	7.766	< .001	0.74
N (%)	**Total**	**Men**	**Women**	$\chi^{2\,(2,444)}$	*p*	*Cramer's V*
Underweight	22 (5.0)	1 (0.5)	21 (8.4)	31.208	< .001	0.265
Normal weight	344 (77.5)	142 (72.8)	202 (81.1)			
Overweight	78 (17.6)	52 (26.7)	26 (10.4)			

Subjective sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) in its Spanish adaption (Macías, & Royuela, 1996), which has shown a high internal consistency (Cronbach's alpha of .81). In the work of Buysse et al., (1989) the predictive validity data indicated that using a cut-off point of 5 (a score > 5 indicates worse sleep quality), the sensitivity was 89.6% and the specificity 86.5%. The 19 items analyzed determinants of sleep quality, grouped into seven components: quality, latency, duration, efficiency, sleep disturbances, use of sleeping medication, and diurnal dysfunction. Each component is scored from 0 to 3. From the sum of the seven components, the total PSQI score is obtained, which ranges from 0 to 21 points (the higher the score, the poorer the sleep quality). In this study the PSQI has shown acceptable reliability, with α = .675.

Procedure

Using an ex-post facto design and a non-probabilistic convenience sampling procedure, the participants were recruited from the Degrees of Psychology, Early Childhood Education, Primary Education, and Social Education, at the University of Huelva (Southern Spain).

Data collection was carried out during the non-exam period. Student volunteers - both smokers and non-smokers- were recruited through digital platforms, social networks, in classrooms, and by attending the events of the tobacco-free day held at the university. All suitable volunteers (i.e. those that reported meeting the inclusion criteria) were contacted, after which the researchers conducted a brief face-to-face interview to verify that they met these criteria. The criteria for participation in the study were as follows: to be a university student; to not suffer from respiratory diseases or other diseases that require medication; and to not present diagnostic sleep problems or consumption of other substances (for example, marihuana or cocaine). Any participant who reported smoking cigarettes on a daily basis -regardless of the quantity- was considered to be a smoker.

All the participants gave informed consent and filled in pencil and paper tests in a designated classroom. The study was approved by the bioethics committee of the university and followed the recommendations of the Helsinki Declaration (1975-2000).

Data analyses

First, frequency and descriptive statistics (mean and standard deviation) were calculated for the variables according to the gender of the participants and their smoking status. To identify differences in mean scores for both the PSQI and FTND between groups based on gender and smoking status, the Student's t test for independent samples was applied with its corresponding effect size [Cohen's *d*, in which a small effect size is 0.2-0.3; medium effect size is around 0.5, and a large effect size is > 0.8] (Cohen, 1988). For the categorical variables, nicotine dependence (high, moderate, and low) and the groupings based on scores on the PSQI and FTND, the comparison between groups (gender and smoking status) was conducted by means of the Chi-square test ($\chi 2$, df) and its corresponding effect size (phi). Pearson's r and Odds Ratios [OR] were calculated with a 95% Confidence Interval (95% CI) was used to determine the risk of smokers having sleep problems. Finally, an analysis of variance (ANOVA) (*F*), with its corresponding effect size), was used to compare the differences in mean scores among the groups categorized according to nicotine dependence (high, moderate, and low) in the smoker. These differences were then explored using the post hoc Tukey's test, adopting a level of significance of $p < .05$. Finally, a mixed ANOVA was conducted to test whether smoking variables and gender interact in influencing sleep quality. Statistical assumptions were checked, including normality and homoscedasticity. All assumptions were reasonably met. The criterion for statistical significance was set at 0.5.

Results

Of the sample, 45.7% obtained scores above 5 on the PSQI, which indicates poor sleep quality, with the women being most prevalent in this group (p = .02) (See Table 2). Through the use of the Student's t-test for independent samples it was confirmed that women report a poorer quality of sleep than men (d = 0.23).

Table 2: Scores on the Pittsburgh Sleep Quality Index and the Fagerström Test for Nicotine Dependence according to the gender of the sample.

		Total N=444	Men N=195 (43.92%)	Women N=249 (56.08%)			
		M (SD)	*M (SD)*	*M (SD)*	*t*	*p*	*Cohen´s d*
PSQI-Total		5.74 (2.661)	5.40 (2.713)	6.00 (2.560)	2.387	.017	0.23
		N=183	N=83 (45.36%)	N=100 (54.65%)			
FTND-Total		*M (SD)*	*M (SD)*	*M (SD)*			
		2.06 (2.187)	2.53 (2.292)	1.67 (2.025)	2.694	.008	0.40
		n (%)	*n (%)*	*n (%)*	x^2	*p*	*phi*
PSQI					$5.544_{(df=1)}$	.020	0.11
	>5 points	203 (45.7)	77 (39.5)	126 (50.6)			
	≤5 points	241 (54.3)	118 (60.5)	125 (49.4)			
FTND					$4.303_{(df=2)}$	.116	0.15
	Low Dep	158 (86.3)	67 (80.7)	91 (91.0)			
	Mod Dep	15 (8.2)	9 (10.8)	6 (6.0)			
	High Dep	10 (5.5)	7 (8.4)	3 (3.0)			

PSQI-Total: Total scores on the Pittsburgh Sleep Quality Index, *FTND-Total:* Fagerström Test for Nicotine Dependence, *Low Dep*: Low Dependency, *Mod Dep*: Moderate dependency, *High Dep*: High dependency

When observing the total FTND scores it is clear that women have less dependence on nicotine (d = 0.40). It was observed that 86.3% of the sample of smokers presented a mild addiction, with no notable differences between men and women. Considering the type of response given to each of the items of the FTND according to the gender of the students, the Chi-square test did not reveal differences on any of the items (Table 3). There was, however, a tendency for men to report smoking a greater number of cigarettes per day, although this difference failed to reach significance (p = .064).

The Pearson's test revealed a significant correlation between the scores on the PSQI and the FTND (r = .186, p = .012). Smokers present a greater risk of poor sleep quality (> 5 points in the PSQI) than non-smokers, with an *Odds Ratio* (*OR*) = 1.42 (*95% CI* [.990-2.074] with $\chi^2_{(1,444)} = 3.361$, *Phi* = 0.086 and p = .05).

Table 3: Distribution of the participants according to gender and their responses to the Fagerström test items.

	Total 444	Gender				
		Men N=195 (43.92%)	Women N=249 (56.08%)			
	n (%)	*n (%)*	*n (%)*	x^2	*df*	*p*
Smokers				0.261	1	.610
Yes	183 (41.2)	83 (42.6)	100 (40.2)			
No	261 (58.8)	112 (57.4)	149 (59.8)			
Time elapsed until the 1st cigarette				6.810	3	.078
≤ 5 min.	11 (6.0)	8 (72.7)	3 (27.3)			
6 to 30 min.	37 (20.2)	18 (48.6)	19 (51.4)			
31 to 60 min.	46 (25.1)	24 (52.2)	22 (47.8)			
> 60 min.	89 (48.6)	33 (37.1)	56 (62.9)			
Smoking in prohibited places				0.312	1	.576
Yes	30 (16.4)	15 (50.0)	15 (50.0)			
No	153 (83.6)	68 (44.4)	85 (55.6)			
Cigarette to give up				3.091	1	.079
1st of the morning	46 (25.1)	26 (56.5)	20 (43.5)			
Other	137 (74.9)	57 (41.6)	80 (58.4)			
Nº cigarettes per day				5.511	2	.064
<10	124 (67.8)	49 (39.5)	75 (60.5)			
11 to 20	53 (29.0)	30 (56.6)	23 (43.4)			
>20	6 (3.20)	4 (66.67)	2 (33.33)			
Smoking more frequently during the first part of the day				2.506	1	.113
Yes	25 (13.7)	15 (60.0)	10 (40.0)			
No	158 (86.3)	68 (43.0)	90 (57.0)			
Smoking when ill				2.724	1	.099
Yes	57 (31.1)	31 (54.4)	26 (45.6)			
No	126 (68.9)	52 (41.3)	74 (58.7)			

When comparing the mean scores obtained on the PSQI (Table 4), a Student's t-test revealed that smokers obtained a worse total score on the sleep test (d = 0.31), sleep less hours than non-smokers (d = 0.38), and spend less hours in bed (d = 0.24). If each of the seven items of the PSQI is considered, there are differences on Item 1: Subjective sleep quality (d = 0.19), on Item 2: Sleep latency (d = 0.21), on Item 3: Sleep duration (d = 0.36) and on Item 5: Sleep disturbance (d = 0.30). Smokers, in comparison with non-smokers, showed scores on most items that are indicative of poor sleep quality. However, no differences were observed in terms of sleep efficiency, the use of medication, or in diurnal dysfunctions related to sleep.

Table 4: Relationship between smoking and non-smoking status on scores on the PSQI variables.

	Smoker				
	Yes N=183 (41.22%)	No N=261 (58.78%)			
	M (SD)	*M (SD)*	*t*	*p*	*Cohen's d*
PSQI-TOTAL	6.22 (2.824)	5.40 (2.490)	3.182	.002	0.31
Hours of sleep	6.64 (0.865)	6.99 (0.979)	3.913	< .001	0.38
Hours spent in bed	7.51 (1.110)	7.77 (1.051)	2.568	.011	0.24
Comp. 1. Subjective sleep quality	1.09 (0.693)	0.96 (0.690)	1.969	.050	0.19
Comp. 2. Sleep latency	1.43 (0.963)	1.23 (0.903)	2.169	.031	0.21
Comp. 3. Sleep duration	0.93 (0.551)	0.72 (0.603)	3.876	< .001	0.36
Comp. 4. Sleep efficiency	0.30 (0.640)	0.26 (0.547)	0.775	.439	0.07
Comp. 5. Sleep disturbance	1.17 (0.479)	1.04 (0.385)	2.982	.003	0.30
Comp. 6. Use of medication	0.30 (0.655)	0.23 (0.619)	1.129	.259	0.11
Comp. 7. Diurnal dysfunction related to sleep	1.01 (0.835)	0.96 (0.748)	0.578	.563	0.06

PSQI-TOTAL. Total scores on the *Pittsburgh Sleep Quality Index*.

The mean scores obtained on each of the PSQI items (Table 4) allow us to determine which group (smoker or non-smoker) obtained the highest score. These mean scores, however, are not particularly descriptive. Therefore, we considered that it would be more informative to group the four response categories on Item 2: Sleep Latency (0 = Less than 15 min; 1= Between 16-30 min; 2 = Between 31-60 min; 3 = More than 60 min) into only two categories (Short Latency: ≤ 30 minutes and Long Latency :> 30 minutes). It is then observed that smokers have a greater risk of long sleep latency with an *OR* = 1.50 (*95% CI* [1.018-2.213] with a $\chi^2_{(1,444)} = 4.220$, $p = .040$ and *Phi* = 0.097). However, if Item 3: Sleep Duration (0 = Greater than 7 hours, 1 = Between 6-7 hours, 2 = Between 5-6 hours and 3 = Less than 5 hours) is similarly grouped into only two categories (Low Duration of Sleep: <6 hours and Long Duration of Sleep: > 6 hours) it is not possible to observe differences between smokers and non-smokers, with an *OR* of 1.56 (*95% CI* [0.831-2.933] and a $\chi^2_{(1.444)} = 1.944$, $p = .163$ and *Phi* = 0.163). When Item 5: Sleep Disturbances or the frequency during the last month of sleep difficulties due to seven different reasons, with a response range of 0, 1-9, 10-18 and 19-27 points, were similarly divided into only two categories (Low Disturbance: 0, 1-9, and High Disturbance: 10-18 and 19-27), it was found that smokers have a greater risk of presenting higher sleep disturbance with an *OR* = 2.45 (*95% CI* [1.391-4.304] with a $\chi^2_{(1,444)} = 10.075$, $p = .002$ and *Phi* = 0.151). No significant differences were detected for the remaining items.

Table 5 displays the results of the ANOVA conducted to compare the mean scores obtained on the PSQI by the smokers according to their classification into Low, Moderate, or High Nicotine Dependence.

Table 5: Total scores and scores on each item of the PSQI according to response categories of the smokers on the Fagerström test.

	FTND					
	Low Dependence N=158 (86.3%)	Moderate Dependence N=15 (8.2%)	High Dependence N=10 (5.5%)			
	M (SD)	*M (SD)*	*M (SD)*	$F_{(2,182)}$	*p*	η^2
PSQI-TOTAL	6.13 (2.771)	5.73 (2.492)	8.50 (3.375)	3.672	.027	0.04
Comp. 1. Subjective sleep quality	1.08 (0.692)	1.07 (0.799)	1.40 (0.516)	1.040	.356	0.01
Comp. 2. Sleep latency	1.42 (0.973)	1.20 (0.775)	1.80 (1.033)	1.170	.313	0.01
Comp. 3. Sleep duration	0.94 (0.532)	0.73 (0.704)	1.10 (0.568)	1.479	.231	0.02
Comp. 4. Sleep efficiency	0.28 (0.639)	0.33 (0.724)	0.50 (0.527)	0.551	.577	0.01
Comp. 5. Sleep disturbances	1.16 (0.459)	1.07 (0.458)	1.50 (0.707)	2.826	.062	0.03
Comp. 6. Use of medication	0.26 (0.620)	0.47 (0.743)	0.60 (0.966)	1.849	.160	0.02
Comp. 7. Diurnal dysfunction related to sleep	0.98 (0.802)	0.87 (0.915)	1.60 (1.075)	2.865	.060	0.03

FTND: *Fagerström Test for Nicotine Dependence*. PSQI-TOTAL: *Total scores on the Pittsburgh Sleep Quality Index.*

It can be observed that only for the total score were differences found between the three groups, with these differences being small (η^2= 0.04). In particular, the High Dependency group differed markedly from both the Low Dependency group (p = .029) and the Moderate Dependency group (p = .048). Although there were no statistically significant differences, scores on Item 5, which refer to sleep disturbances, and Item 7, which measure diurnal dysfunctions related to sleep, revealed marginally significant differences between the High Dependency group and the other two groups, which showed similar scores. In order to explore the existence of a possible interaction between gender and smoking behavior, a univariate analysis was carried out according to the general linear model, confirming the absence of an interaction ($F^{(5,182)}$ = 0.895, p =. 410). Thus, independently of the participant's gender, smoking and quality of sleep appear to be interrelated.

Discussion

In Spain, there have been no studies that have explored the link between nicotine dependence and subjective sleep quality in cigarette smoking students. Thus, the current study attempted to analyze, in a sample of such students, how the perceived quality of sleep differs between smokers and their non-smoking counterparts. We also aimed to identify if the degree of nicotine dependence is related to the perceived quality of sleep and whether there were any differences according to gender in this sample of smoking students. Given that no differences were expected according to academic degree, based on the work of Álvarez-Pérez et al. (2017), no further analyses were conducted.

The data collected have shown that 41.2% of students report smoking daily, with men obtaining the highest scores on the scale of nicotine dependence. In addition, 45.7% of the students analyzed in our sample present poor sleep quality, as indicated by

scores above 5 on the PSQI, with women showing the poorest sleep quality. The data confirm that student smokers have a poorer quality of sleep (and an increased risk for this problem) compared with non-smokers. Although various mechanisms have been proposed by which nicotine can alter sleep quality (Zhang, Samet, Caffo, & Punjabi, 2006), the possibility that poor sleep quality could increase cigarette consumption should also be considered.

With respect to our second objective, which was to identify whether the degree of dependence on nicotine is related to sleep quality, it has been observed that those who have a high dependence on nicotine show a poorer quality of sleep compared with those having low and moderate dependence, although the size of the effect was small, and there were no differences according to gender.

One striking aspect of our findings is the high percentage of smokers who, on the Fagerström Test for Nicotine Dependence (FTND), obtained scores indicative of low dependency (86.3%) or average dependency (8.2%). However, these data are very similar to those reported by Zurita et al. (2018) who found that 14.56% of university students show low dependency and 85.44% show average dependency, with no students belonging to the high dependency category. This fact could be explained, in part, by the impact of the laws regulating the consumption of tobacco in the population, particularly the restrictions imposed on smoking in public spaces (Pinilla, López-Valcárcel, & Negrín, 2018). Given that nicotine dependence is directly related to the number of cigarettes smoked, it could be argued that these regulatory laws, together with reducing exposure to environmental tobacco smoke (second-hand smoke) could have implications for smoking cessation (Fichtenberg, & Glantz, 2002; Callinan, Clarke, Doherty, & Kelleher, 2010; Frazer et al., 2016). In particular, such laws could increase awareness of the harmful effects of tobacco (Albers, Siegel, Cheng, Biener, & Rigotti, 2007; Brown, Moodie, & Hastings, 2009), whilst not being allowed to smoke in public (in cases where this law is applied) could reduce the number of cigarettes smoked later or could help smokers who wish to quit completely (Levy, & Friend, 2003; Nagelhout et al., 2012).

Further, with regard to the prevalence of tobacco consumption, the data collected here are broadly similar to the findings of previous studies, such as the 45.7% reported by Rigoti et al. (2000) and the 46.9% reported by Alexopoulos et al. (2009); but higher than the 24.8% indicated by Bakar et al. (2013) and the 37.7% reported by Molina et al. (2012). In terms of gender differences, whilst a difference in the number of male and female smokers was not found, men showed a significantly greater dependence on nicotine than women.

Regarding subjective sleep quality, 45.7% appear to have poor sleep quality, which is much lower than previously reported estimates (Lund et al., 2010). However, our data have confirmed that women appear to have the worst quality of sleep, a finding that is in line with other studies on the general population that revealed a similar finding (Diestel, Rivkin, & Schmidt, 2015; Kamphuis & Lancel, 2015). This suggests that such differences should be taken into account when establishing relationships between sleep quality and smoking. In our student sample, a positive relationship was found between being a smoker and presenting problems with sleep, as previously found in the general population of smokers (Cañellas, & Lecea, 2012; Cohrs et al., 2014; Zhang et al., 2006). Moreover, students who smoke have fewer hours of sleep and spend fewer hours in bed compared with non-smokers. Similarly, the smokers in our sample experience poorer sleep quality, longer sleep latencies, and a greater number of disturbances during sleep, as previously demonstrated in the general population of smokers (McNamara et al., 2014; Tang et al., 2015). However, unlike the findings reported by Zhang et al. (2006) in the general population of smokers, our data have failed to confirm that smokers show a greater diurnal dysfunction related to sleep. Similarly, no differences in sleep efficiency were found between smokers and non-smokers, as indicated by Zhang et al. (2008) in the general population.

Whilst previous studies have shown direct relationships between the quantity of tobacco consumed and problems with sleep quality (Mehari et al., 2014; Zhang et al., 2008), the data provided here only partially support this possibility. In the

present study it was found that only students with scores reflecting a high dependence on nicotine are those who obtain a higher total score on the PSQI, i.e. a worse quality of sleep, although the effect size is small. For the each of the items, no differences were observed. It is also worth noting the existence of a (non-significant) trend where those smokers with a high dependence on nicotine reported a greater number of sleep disturbances and more diurnal dysfunction derived from the use of tobacco. Furthermore, these findings were obtained independently of the gender of the participants, as confirmed by the lack of a significant interaction between the smoking behaviour variables and gender.

Among the limitations of this work, it is important to highlight the use of subjective measures for both the quality of sleep and the consumption of tobacco. This aspect of our procedure must be taken into account since, although it is important to consider how sleep is perceived, it is equally important to consider physiological activity through more objective evaluation instruments, since in many cases the data obtained using questionnaires often differ from the results found when using actigraphy (Fietze et al., 2009). This limitation could similarly apply to our measure of tobacco consumption. Along with this, it is interesting to highlight an apparent limitation of the tests used to assess the quality of sleep and nicotine dependence in this study. These are widespeared and heavily used tests in the literature, and even though there is evidence for their low internal consistency, this has been explained with relevant arguments that justify their use, both in the case of the Fagerström Test for Nicotine Dependence (Haddock, Lando, Klesges, Talcott and Renaud, 1999) and for the Pittsburgh Sleep Quality Index (de la Vega et al., 2015; Magee, Caputi, Iverson, & Huang, 2008; Mollayeva et al., 2016).

It is also worth pointing out that the type of design used -which is non-experimental- does not allow for establishing causal relationships, even though we have attempted to show how smokers perceive the quality of their sleep.

One aspect of our findings that should be considered with caution is the internal consistency shown on both tests. Although the reliability data obtained for the Fagerström Test for Nicotine Dependence (FTND) was higher than that reported by the authors of the original test (Fagerström, & Schneider, 1989) the same did not occur with the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989). However, the internal consistency we obtained on the PSQI was similar to that reported in previous studies (Cronbach's $\alpha = 0.66$) (Dugas et al., 2017; Mollayeva et al., 2016).

Similarly, in spite of ensuring that data collection was not carried out during the exam period and that there were no health problems related to sleeping difficulties and/or taking medication, in future work it might be of interest to explore other variables that may influence the quality of sleep (e.g., coffee consumption, use of drugs, or physical activity).

This work provides a preliminary approach to the study of nicotine dependence and how it relates to the perceived quality of sleep in Spanish university smokers. Whilst any conclusions drawn on the basis of the data obtained here should be treated with caution when attempting to generalize to other populations, at least in the university context, our findings are in line with the results reported in previous studies with students from other countries. Future studies should consider the time at which the data are collected (for instance, exam period or non-exam period), whilst it might also be worth conducting a longitudinal study with larger and more representative samples of the university community, possibly grouping the students according to the type of subject being studied. Similarly, it might be of value to work with university populations that present differential characteristics in terms of variables not explicitly considered in this study, such as BMI, presence of diseases (e.g., cardiovascular, respiratory), drug consumption, or level of physical activity.

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