Title: Don't worry, Sleep well: Predictors of sleep loss over worry

Running Title: Predictors of sleep loss over worry

Authors:

Daniel Ruivo Marques

- University of Aveiro, Department of Education and Psychology, Campus Universitário de Santiago,   3810-193 Aveiro, Portugal

- Institute for Biomedical Imaging and Life Sciences, IBILI, Azinhaga de Santa Comba, 3000-548 Coimbra, Portugal

Ana Allen Gomes

- University of Aveiro, Department of Education and Psychology, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal

- CINTESIS - Center for Health Technology and Services Research. Centro de Investigação Médica, Faculdade de Medicina do Porto. R. Dr. Plácido Costa, 4200-450 Porto, Portugal

Manuela Frederico Ferreira

- Nursing School of Coimbra, Portugal, Rua 5 Outubro, 3046-851 Coimbra, Portugal

Maria Helena Pinto de Azevedo

-University of Coimbra, Faculty of Medicine, Rua Larga, 3004-504 Coimbra, Portugal

Author's address (Corresponding author):

Daniel Ruivo Marques

Department of Education and Psychology, University of Aveiro

Campus Universitário de Santiago

3810-193 Aveiro, Portugal

Phone: +351 234 372 428

E-mail: drmarques@ua.pt

Compliance with Ethical Standards

Conflict of Interest: Daniel Ruivo Marques, Ana Allen Gomes, Manuela Frederico Ferreira and Maria Helena Pinto de Azevedo declare that they have no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Abstract

In this study, our aim was to explore the relationship between sleep quality/quantity, chronotype, pre-sleep arousal, arousability, stress, coping, neuroticism, extraversion, mood/affect, perceived health and sleep loss due to worry in college students. A total of 713 students (mean age=19.29±1.256 years) completed a set of questionnaires that assessed sleep loss over worry (item from the General Health Questionnaire), other sleep-wake aspects (e.g., habitual sleep duration, sleep needs, sleep depth, subjective sleep quality, sleep latency, night awakenings, daytime sleepiness, sleep flexibility, sleep reactivity to stress), pre-sleep arousal (cognitive/somatic arousal), arousability, coping, neuroticism, extraversion, perceived physical/mental health, academic stress, and positive/negative affect. Sleep disturbance due to worry was reported by 40.6% of females and 19.2% of male students. It was significantly correlated with perceived health and the majority of sleep-wake variables. Almost all correlations between the psychological traits under study and sleep loss over worry were significant. Results from the stepwise regression analyses, however, showed that only cognitive arousal (β=.353; $p<.001$), perceived academic stress (β=.129; $p<.01$), arousability (β=.127; $p<.01$), worry tendency (β =.153; $p<.001$), gender (β =.118; $p<.01$), and perceived physical health (β=-.093; $p<.01$) were significant predictors of sleep loss over worry. Together, these variables accounted for 40.3% of the total variance in sleep disturbance due to worry. Our findings suggest that cognitive arousal, academic stress, arousability, tendency to worry, gender and perceived physical health may be important determinants of sleep loss over worry. These results may have important implications for prevention and intervention to improve sleep quality in young adults.

A rich man loses weight by wakeful nights, (…) sleepless worry keeps him wide awake,

just as serious illness banishes sleep

Ecclesiasticus, 190 B.C.

Worry is perhaps the biggest single factor behind sleeplessness

Peter Tyrer (1978)

Introduction

Worry is a central construct in human psychological functioning. Its connection to sleep and sleep dysfunction has been observed by clinicians and writers since more than 2000 years [1,2]. However, research regarding the key role that worry may play in sleep behavior is scarce.

Regarding clinical settings, we found two researches exploring more explicitly this topic: in a study of primary care patients (n=157), the most common perceived causes for their disturbed sleep were "nerves" (34.2%) and "worries/problems" (32%) [3]. Carvalho, Ribeiro, Martins, Ferreira and Azevedo [4] carried out a study about sleep disturbances in a sample of 131 cancer patients undergoing chemotherapy. Forty-two percent of the participants reported sleep problems. In their opinion, the principal causes of sleep problems were worries related to the disease/treatment (38.3%), anxiety/preoccupations/grief, familiar problems (21.8%).

We have found only a single study which focus this matter in the community. In a recent population-based investigation of the UK (n=7.403) among the respondents who offered a specific reason for their sleep problems, worry/thinking (37.9%) was the most common, followed by illness/discomfort (20.1%). It was also found that the prevalence of sleep disturbance because of worry was higher in women and the age distributions of the

most common reasons provided by respondents showed that sleep disturbance through worry reached a peak in early working lives then declined whereas sleep problems through illness, increased with age, plateauing in late middle age

Since there were no formal scale to assess sleep worry due to worry, Kelly [5] developed the *Sleep Disturbance Ascribed to Worry Scale* (SAW). This is a self-report questionnaire comprising 5 items intended to evaluate the effects of worry on sleep. It has 11 response options (0=never, 10 =very often). Higher scoring suggests higher sleep loss due to worry levels. A study by Kelly [6] evaluated the association among sleep loss due to worry, habitual sleep length and worry frequency measured by the *Worry Domains Questionnaire* (WDQ [7]) on a sample of 222 college students (152 females; mean=24 yrs). Forty-six of the participants were also invited to describe their quality of sleep (1 item) in a 11-point Likert-type scale ranging from "awful" to "great"). The results suggested the sleep disturbance attributed to worry impaired the quality and habitual sleep length; besides, it was associated with higher levels of worry.

In a subsequent study, Kelly [5] carried out two correlational studies using SAW as well. In the first one, comprising 95 college students (70 females; mean= 26.5 yrs), the results showed the sleep loss due to worry was related with higher levels of general worry, anxiety and stress perception and lower levels of life satisfaction and happiness. In study 2, comprising also a college students sample (*n*=117; 70 females), the correlations with stress, worry and somatic anxiety were replicated and it was found that sleep loss due to worry was significantly associated with increased negative affect, depression, general sleep disturbance and decreased self-esteem.

Beyond Kelly´s works, we found only a single study on the association among sleep disturbance caused by worries and sleep and psychological variables. In the already mentioned study by Dregan et al. [8], sleep disturbance, general worry, depression, anxiety

and poor health perception, were differently distributed according to different reasons given for sleep problems. Sleep disturbance because of "worry/thinking" was often associated with sleep-onset problems (41%) and waking up more than two hours early (43%).

Regarding severity of sleeping problems it was concluded that it was higher when the reason was illness, followed by "worry/thinking". When analyzed the associations pattern between general worry, depression and anxiety and reasons for sleep problems, as expectable, the highest percentage belong to the group whose reasons were "worry/thinking", (32%); with anxiety and depression represented in equal proportions (15%). Finally, those with poor self-reported health status, as might be expected, were more likely to report sleeping problems if the reason was illness (9%) or taking medication (8%), but this group also scored highly if the reason was "worry/thinking" (6%). Furthermore, as shown in several studies worry-related sleep complaints is a predictor of cardiovascular morbidity and mortality [9,10] and may increase the risk of alcohol-related [11].

Given this link with adverse clinical events, in a recent study, Salo et al. [12] examined the evolution of sleep loss due to worry across the lifespan on two large European cohorts (Whitehall II study and Finnish Public Sector study) by sex and age group. In both studies, sleep was assessed using a single item which asked participants to think about the past few weeks when responding to the question "Have you recently lost much sleep over worry?". Responses were dichotomized to indicate the presence ("rather more than usual" and "much more than usual") or absence ("not at all" and "no more than usual") of sleep complaints.

In the UK study prevalence at baseline was 14%, and 49% of the participants reported sleep lost over worry at least once at some point during the study (mean 21.6 yrs of follow-up) whereas in Finnish Public Sector study baseline prevalence was 22% and 51% of the participants reported sleep lost over worry at least once during the study (mean 10.9 yrs of follow-up).

In both studies, the prevalence of sleep disturbance due to worry was higher in women and decreased significantly with age in both sexes.

In Kelly´s studies [5,6] there are some significant limitations: reduced sample size and absence of relevant measures related to arousability, pre-sleep cognitions or sleep disturbances in order to evaluate which variables account for sleep loss over worry [5]. Therefore, the aims of our study were (1) to examine the association among sleep-wake variables, arousability, cognitive/somatic pre-sleep arousal, personality traits, stress, coping, mood/affect, perceived health and sleep loss due to worry, and (2) to explore which psychological variables constitute the most significant predictors of sleep loss due to worry in a sample comprising college students.

METHOD

This study was approved by the Ethical Committee and the Scientific Council of the Faculty of Medicine of the University of Coimbra.

Participants

In this study participated 713 students (mean age: 19.29; SD=1.256; range=17-24 yrs) from the first to third year of the Medicine Course. Two hundred and forty-five (34.4%) were males (mean age=19.22 years; SD=1.227) and 468 (65.6%) were female (mean age=19.34 years; SD=1.271). There was no significant difference between both groups (p=.22; n.s.).

Measures

NEO Personality Inventory Revised (NEO-PI-R)

The NEO-PI-R [13] operationalizes the five personality factors model and provides a comprehensive, multidimensional assessment of adult personality. For the present study purposes, we selected five facets of Neuroticism: Anxiety (N1), Hostility (N2), Depression (N3), Impulsiveness (N5) and Vulnerability (N6).

Eysenck Personality Inventory (EPI)

The short version of the EPI (EPI-12) [14] was used to evaluate Extraversion (E) and Neuroticism (NE). The item "I suffer from sleeplessness" was removed from NE, as it might constitute a confounding variable.

Repetitive thought

The general tendency to worry and overthinking/rumination was measured with a scale comprising four items: Two items assess the tendency to worry: ("I worry a lot", "The people around me consider that I worry a lot") and two items assess the tendency to overthinking/rumination ("I think a lot over things", "The people around me consider that I think a lot over things"). Each item is scored from 1=almost never to 4=almost always [15].

Arousal predisposition scale (APS)

The APS is constituted by 12 items measuring predisposition to arousability. Each item is answered on a 4-point scale (1=almost never to 4=almost always). The higher the scores, more predisposition to arousability [16].

Pre-Sleep Arousal Scale (PSAS)

The PSAS contains 16 items, each rated on a 5-point scale that describes symptoms of arousal at bedtime [17]. Eight items evaluates cognitive arousal and eight evaluates somatic arousal. Higher scores suggest higher pre-sleep arousal.

Profile of Mood States (POMS)

The POMS [18] is constituted by 65 adjectives describing feelings and emotions that people usually experience. Each item is responded on a 5-point scale: 0=by no means to 4=very much. Seven mood states are evaluated: Tension-Anxiety, Depression-Rejection, Fatigue-Inertia, Anger-Hostility, Vigour-Activity, Agreeableness and Confusion-Disorientation. In this study, subjects should consider the previous month (not the previous week, as originally requested), as we wanted to evaluate affect associated with traits, not transitory states of humor [18]. The "Negative Affect" (NA) dimension was constituted by summing the scores from anxiety, depression, fatigue and anger scales; The "Positive Affect" dimension (PA) summing the scores on the vigor and friendliness scales.

Emotion Regulation Questionnaire (ERQ)

The ERQ [19] assesses two emotion regulation strategies: cognitive reappraisal and expressive suppression. Response options range from 1=strongly disagree to 7=completely agree.

Stress Sources Inventory (SSI)

SSI assesses the main perceived stressors of university students in the Portuguese context [20]. It comprises 24 items, rated on a 5-point scale (from 1= strongly disagree to 5=strongly agree). In our study only Academic Stress subscale (Factor 1- 13 items) was used.

Preferences Scale (PS)

The PS [21] is a measure of morningness, comprising six questions about time for preferences for mental work and six about physiological rhythms. Each question is answered in a 5-point scale: much earlier than other people=1 to much later than other people=5.

Morningness/Eveningness

Morningness/Eveningness (chronotype) was assessed using the following question: "Do you think you are a more morning or nocturnal-type person?" The response categories were: Definitely a morning-type =1, More matinal than nocturnal =2, Neither matinal nor nocturnal=3, More nocturnal than matinal=4, Definitely a nocturnal-type =5. We explored the association between this item and the two factor from PS ($r = .4$; $p<.001$).

Sleep-wake variables

1. *Habitual Sleep Duration* – "How many hours do you usually sleep per night?" (scored 1=5 hours or less to 9=11 hours or more);

2. *Sleep Depth* – "Ever since you can remember how has been the depth of your sleep?" (scored 1=very deep to 5=so light that anything wakes me);

3. *Subjective Sleep Quality* – "Ever since you can remember how has been your sleep quality?" (scored 1=very good to 5=very poor);

4. *Sleep Needs* – "In your case how many hours do you need to sleep to feel good and function well during the day?" (scored 1=5 hours or less to 9=11 hours or more);

5. *Sleep Flexibility* – "Do you think you are the kind of person for whom it is very easy to fall asleep at any time of day and anywhere?" (scored 1=never/almost never to 4=always/almost always).

6. *Sleep Latency* – "How long does it take to you to fall asleep?" (scored 1=1-14 minutes to 5=60 minutes or more);

7. *Nocturnal awakenings* – "How many times do you wake up at night?" (scored 1=0 times to 7=6 times or more).

8. *Time to get-up* – "How long does it take you to get up after waking up? (scored 1= 1-14 minutes to 5=more than 60 minutes).

Sleep Quality Index (SQI)

Based on the scores on Sleep Depth, Subjective Sleep Quality, Sleep Latency and Nocturnal awakenings we created a SQI. The score varies from 3 to 21. Higher scores suggest greater sleep disturbance. The Cronbach´s alpha coefficient of SQI was acceptable (α = 0.65). One should note that Cronbach´s alpha coefficients > .7 are normally the guideline when one is developing or adapting a scale, for example. For exploratory studies, for instance, values of α ≥ .60 are considered acceptable.

Perceived Daytime Sleepiness (PDS)

To evaluate PDS the sum of the scores on four items was used: During the day I feel excessively sleepy, full of sleep; Being sleepy during the day is a problem for me; During the day I feel that my performance is impaired by being sleepy"; During the day I feel the need to take a nap". All item are scored from 0=never to 5=always. No specific time frame specified.

Epworth Sleepiness Scale (ESS)

The ESS [22,23] assesses the propensity of "dozing or falling asleep" in common situations of daily living such as sitting and reading; watching TV; sitting in a public place. It has eight items scored from 0–3, with scores ranging from 0 to 24 points. The normal upper limit of ESS total score is generally considered to be 10 points.

Sleep loss over worry

Sleep loss over worry was evaluated with a single item, "I lose sleep over worries" (adapted from General Health Questionnaire-12) rated on a four-point scale from 1= almost never to 4 =almost always. No specific time frame is specified. Higher scores denote greater worry-related sleep disturbance.

Self-Perceived Insomnia

The self-perception of insomnia was assessed with a single item from the EPI-12: "I suffer from sleeplessness" [14], rated on a four-point scale with 1= almost never, 2= quite seldom, 3= quite often and 4 =almost always.

Self-Perceived Health

Self-perceived physical and mental health status was assessed with two questions: "Generally, what has your physical health been like?" and "Generally, what has your psychological (mental) health been like?". The responses could range between very poor=1, poor=2, neither good nor poor=3, good=4, very good=5.

Procedure

Firstly, we contacted the professors of the first three years of the Faculty of Medicine of University of Coimbra in order to obtain authorization to administer the questionnaires at the beginning/ending of practical lessons. After the aims of the study had been explained to the students, they were invited to filled out the instruments during the month of November (academic years: 2007-2008 and 2008-2009) out of the evaluations period. It was emphasized that their cooperation was voluntary, and confidentiality was ensured. All students present in class returned the questionnaires. Thus, the adhesion rate was of 100%.

Statistical analysis

All statistical analyses were computed using IBM Statistical Package for Social Sciences (SPSS) Statistics, version 20. We calculated frequencies, mean, standard deviations and range of variables. In order to analyze association among the different variables we calculated the Pearson´s Product-Moment coefficient. Cohen´s criteria [24] were used to interpret the effect sizes (.10=small; .30=medium; .50=large). Furthermore, it were computed Student´s *t*-tests to examine eventual differences between sexes and one-way ANOVAs to explore differences among the different groups created from "sleep loss due to worry" dependent variable. When the results were significant, Tukey´s-b test was used as a post-hoc measure. Finally, it was applied a stepwise linear regression in order to identify the psychological predictors variables of sleep loss due to worry.

RESULTS

Sleep loss due to worry prevalence

As shown in Table 1, 17.6 % of males and 34 % of females reported sleep disturbance due to worries "Many times". On the other hand, 1.6 % of males compared to 6.6 % females reported "Almost always". 33.2 % of participants were considered in the joint category "Almost always + Many times", of which 40.6 % were female and 19.2 % were male.

INSERT TABLE 1 HERE

Group comparisons by sex

As shown in Table 2, there are significant differences between sexes in most of psychological variables (12 in19). The mean scores in these variables are significantly higher in females, with exception of positive affect and cognitive reappraisal variables, whose values were higher in males. Concerning to health and sleep variables, it was found that the mean values of self-perceived mental health and self-perception of overall health (mental health + physical health) were significantly higher in males (better health) than in females. In relation to self-perceived physical health, there were no significant differences between the sexes. With respect to sleep-related variables, it were observed significant differences in seven of them (7 in 16), specifically in sleep depth, night awakenings, mental work, morningness/eveningness, sleepiness perception, quality of sleep and sleep loss due to worries, with females presenting highest values in all variables, except mental work and morningness/eveningness, whose values were significantly higher in males (cf. Table 3).

INSERT TABLE 2 HERE

INSERT TABLE 3 HERE

Associations among age, psychological variables and sleep loss due to worry

In Table 4 it were displayed the correlations between age and psychological variables and sleep loss due to worry. The coefficients were significant and positive for most variables (18 in 20). The lowest correlation was $r = .091$ (age) and the higher correlation was $r = .512$ (cognitive arousal).

INSERT TABLE 4 HERE

Associations among health self-perception, sleep variables and sleep loss due to worry

As shown in Table 5, the correlation coefficients between health self-perception and sleep loss due to worry are significant and negative (worse health), ranging from low magnitude in the case of self-perceived health physical ($r = -.224$) to moderate magnitude regarding global health self-perception (i.e., mental health + physical, $r = -.325$). The correlation between habitual sleep duration and sleep loss due to worry is also significant, negative and of low magnitude ($r = -.081$; $p < .05$). As expected, the coefficients are positive and significant with high quality of sleep index ($r = .511$, $p < .001$) and self-perceived insomnia ($r = .541$, $p < .001$). It was found a significant association between sleepiness perception and sleep loss due to worry ($r = .154$, $p < .001$), albeit no significant association has been verified with sleepiness propensity.

INSERT TABLE 5 HERE

Stepwise Multiple Linear Regression

In order to examine which of the psychological variables under study constituted significant predictors of sleep loss due to worry, we carried out a stepwise multiple linear analysis. All the assumptions of the technique were assumed, namely absence of multicollinearity and outliers [25]. It was found that six variables explain 40.3 % of the variance in scores of sleep disturbance due to worries [$F_{(6, 520)} = 60,089$; $p < .001$]. The variable with the greatest weight in the model was the pre-sleep cognitive arousal (cf. Table 6).

INSERT TABLE 6 HERE

DISCUSSION AND CONCLUSIONS

In this work we explored the relationship among psychological factors, sleep-wake variables, self-perceived health and sleep loss due to worries. As in recent studies performed in the general population, prevalence rates for sleep lost over worries was higher in females (40.6%) than in males (19.2%) [8,12]. Also, the girls reported more worry than boys, which is in agreement with most published studies [26]. In our study, the overall prevalence of sleep loss due to worries was about 33%, which is in accordance with the reported values in epidemiological studies [8,12].

Similar to Kelly´s studies [5,6], our research also found that sleep disturbance related to worries negatively affect the quantity and quality of sleep; the association with quality of sleep index and self-perception of insomnia was also substantial.

An interesting finding is related with daytime sleepiness. It was found that sleepiness perception but not propensity to daytime sleepiness was significantly associated with sleep loss over worries. Although no other study has investigated this topic, the observed

discrepancy may be related to differences in perception of sleepiness and subjective general propensity for sleepiness as measured by the Epworth Sleepiness Scale [27]. Our results and other studies [29] support the need to include questions measuring both constructs in research and clinical settings that rely on self-report to assess sleepiness [30].

Low to moderate magnitude correlations were observed between most psychological variables and sleep disturbance due to worry. These variables (except extroversion and positive affect) were significantly higher in the groups with higher levels of sleep loss due to worries.

As in previous works, we found also a significant association between worry related sleep disturbance with anxiety, depression, negative affect and neuroticism [9,10]. A new finding of this study is the observed association with fatigue-inertia and anger-hostility. However, in college students, fatigue and anger-hostility (also evaluated with the POMS) were associated with poorer quality sleep [30,31].

There was a significant negative association between extroversion and positive affect and sleep loss due to worries. Although Kelly [7] has not included these variables in his study, participants with higher levels of sleep disturbance attributed to worry reported significantly lower life satisfaction, lower levels of happiness and decreased self-esteem. All these variables are strongly associated with positive affect, extraversion, and sleep quality [30]. One should note that LeBlanc et al. [32] also found that extroversion levels were higher in the group of individuals who slept well compared to the group of individuals with insomnia, which as we reported in our study, showed a substantial relationship with the measure of sleep loss over worry we privileged. In a sample of 736 individuals (250 women) aged 58 to 72 years, Steptoe, O'Donnell, Marmot and Wardle [33], have observed that the positive affect and sleep problems were negatively correlated, even when the effects of age and sex were controlled.

It is remarkable the similarity of our results concerning the association between the tendency to worry and sleep loss over worry, with the findings known in the literature [9,10], taking into account the considerable differences in the instruments used.

The perception of academic stress showed up consistently associated with sleep disturbance due to worries, a similar finding to the one described by Kelly [8].

The link between pre-sleep cognitive arousal and the predisposition to arousal with sleep loss over worry is a new finding, albeit expected. In a study by Azevedo et al. [34] comprising a subsample of self-reported "good sleepers" drawn from the current sample, cognitive and somatic pre-sleep activation were significantly associated with sleep quality and self-perception of insomnia; besides, these measures discriminated individuals who slept well from those who slept poorly. These differences were more evident in cognitive arousal domain. These measures were also positively associated with neuroticism (NEO-PI-R), depression and hostility/anxiety (POMS); the highest observed correlations were between depression and cognitive/somatic activation and hostility/anxiety and cognitive activation, whereas friendliness (positive affect) was only significantly associated with pre-sleep somatic arousal, that is, higher levels of positive affect associated with decreased somatic activation.

Regarding APS we found that the mean scores were significantly higher in females than in males which is in accordance with the scoring guidelines from APS based on results by 786 college students. [35] As indicated in the present study, the predisposition for arousal showed consistently an association with sleep disturbance due to worry. Coren [36] in two separate studies with college students (mean age = 18 years), found that scores of activation were positively and significantly associated with sleep disruption and the correlation coefficients found were similar to ours (Study 1: $r = .51$, n = 196; Study 2: $r = .45$, $n = 693$; both $p < .001$). In addition, the highest associations were with frequent nocturnal awakenings and sleep latency [35]. Recent studies with college students (good sleepers) suggest that

cognitive-emotional hyperarousal is a premorbid characteristic of people vulnerable for stress-related insomnia [37,38]. Azevedo et al. [37] analyzed both sexes separately and found that female pre-sleep cognitive arousal, predisposition to arousal (arousability), perceived academic stress, and sleep loss due to worries were all associated with sleep disruption related to stress/transient insomnia. The association between pre-sleep cognitive activation, perceived academic stress and tendency to worry is consistent with the cognitive model of insomnia. According to this model, individuals prone to rumination and worry are more likely to react dysfunctional to life stress events. The generated cognitive activation may interfere with sleep causing consequently insomnia [39].

In our study, self-perceived health status and the tendency to worry proved to be consistently associated with sleep loss due to worries. Also in the study by Dregan et al. [8] the individuals with poorer perceived health had high values if the reason given for their sleep problems, was worry/thinking. In this context, it is important to note that both worry as a trait and sleep disturbance are associated with somatic and psychological health subjective complaints [40,41]. In the study by Kim et al. [41], conducted with participants from general population, the complaints were more prevalent in younger females; furthermore, it was observed that sleeping problems (i.e., difficulty falling asleep, staying asleep and wake-up early) were significantly associated with back pain, epigastric discomfort, weight loss, headache, fatigue, worry, irritability and loss of interest. In the America Insomnia Survey [42], insomnia symptoms were significantly associated with decreased perception of physical/mental health - even after controlling multiple physical and mental comorbid conditions - and distress/daytime impairment (a scale composed by decreased motivation, performance at work, school or social activities, making mistakes or having accidents, irritability, nervousness, mood disorder, attention, concentration and memory daytime, daytime fatigue, daytime sleepiness, and tension headaches or digestive problems). In this

study, the distress/daytime impairment turned out to be a powerful mediator of the association between insomnia and health perception.

Our study presents some limitations. The most important are based on self-report measures and the cross-sectional design that does not enable to determine the causal order among variables. However, it is remarkable the agreement between our results and the ones documented in the literature. Another limitation concerns to the using of sleep-wake indicators as trait-like variables. This may be problematic since the outcomes might have been influenced by recent stressors - such as life events - on sleep perception, for example. Finally, this study focused only on college students of medicine course which may limit the generalization of our findings. Notwithstanding, our results seem to be in accordance with other studies comprising different samples (cf. Introduction). As main advantages, we outline the large nonclinical sample and the simultaneously analysis of a wide variety of sleep-wake and psychological variables. Future longitudinal studies may inform on which sleep and psychological variables are crucial in developing this type of sleep disturbance.

In conclusion, consistent with previous studies, our results show that the sleep disturbance due to worries are significantly associated with poor quality of sleep, higher levels of psychological distress and reduced well-being. The present study suggests that trait characteristics of pre-sleep cognitive arousal, predisposition to arousal, and tendency to worry may play an important role in the disruption of sleep due to worries. Intervention strategies focused on worry, arousal and stress can improve sleep quality and well-being in young people, particularly in women.

Acknowledgements

Conflict of Interest

The authors declare that they have no conflict of interest.

REFERENCES

[1] Furman Y, Wolf SM, Rosenfeld DS. Shakespeare and sleep disorders. *Neurology* 1997 **49**:1171-72.

[2] Iranzo A, Santamaria J, Riquer MD. Sleep and sleep disorders in Don Quixote. *Sleep Med* 2004;**5**:97-100.

[3] Azevedo MH. *Avaliação subjectiva do sono-vigília e fenomenologia da insónia. Lição Síntese*. Provas de Agregação em Psiquiatria. Faculdade de Medicina, Universidade de Coimbra; 1989.

[4] Carvalho J, Ribeiro JS, Martins F. Perturbações do sono no doente oncológico. *Oncology Today* 2005;**4**:34-6.

[5] Kelly WE. Some correlates of sleep disturbance ascribed to worry. *Individual Differences Research* 2003;**1**:137.

[6] Kelly WE. Worry and sleep length revisited: Worry, sleep length, and sleep disturbance ascribed to worry. *J Genet Psychol* 2002;**163**:296-304.

[7] Tallis F, Eysenck M, Mathews A. A questionnaire for the measurement of nonpathological worry. *Pers Indiv Differ* 1992;**13**:161–8.

[8] Dregan A, Lallukka T, Armstrong D. Potential pathways from biopsychosocial risk factors to sleep loss due to worry: A population-based investigation. *J Public Ment Health* 2013;**12**:43-50.

[9] Chandola T, Ferrie JE, Perski A, et al. The effect of short sleep duration on coronary heart disease risk is greatest among those with sleep disturbance: a prospective study from the Whitehall II cohort. *Sleep* 2010; **33**:739-44.

[10] Hamer M, Batty GD, Kivimaki M. Sleep loss due to worry and future risk of cardiovascular disease and all-cause mortality: the Scottish Health Survey. *Eur J Prev Cardiol* 2012;**19**:1437-43.

[11] Crum RM, Storr CL, Chan YF, et al. Sleep disturbance and risk for alcohol-related problems. *Am J Psychiatry* 2004;**161**:1197-1203.

[12] Salo P, Vahtera J, Ferrie JE. Trajectories of sleep complaints from early midlife to old age: Longitudinal modeling study. *Sleep* 2012;**35**:1559-68.

[13] Costa, PT, McCrae RR. *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five Factor Inventory (NEO-FFI) Professional Manual*. Psychological Assessment Resources, Odessa, FL; 1992.

[14] Eysenck HJ, Eysenck, SG. *Manual of the Eysenck Personality Inventory*. London, UK: University of London Press; 1964.

[15] Pereira AT, Marques M, Soares MJ, et al. Worry and rumination: Exploring a brief measure of repetitive thought. *Eur Psychiatry* 2012;**27**:e1058.

[16] Coren S, Mah KB. Prediction of physiological arousability: A validation of the Arousal Predisposition Scale. *Behav Res Ther* 1993;**31**:215-19.

[17] Nicassio PM, Mendlowitz DR, Fussell JJ, et al. The phenomenology of the pre-sleep state: the development of the pre-sleep arousal scale. *Behav Res Ther* 1895; **23**:263-71.

[18] McNair DM, Lorr M, Droppleman LF. *Edits Manual for the Profile of Mood States*. Educational and Industrial Testing Service, San Diego; 1971.

[19] Gross JJ, John OP. Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *J Pers Soc Psychol* 2003;**85**:348-62.

[20] Pereira A, Medeiros A, Lopes P, et al. University Student Stress Inventory: An Exploratory Study. *24th International Conference of the Stress and Anxiety, Book of Abstracts*. pp. 188; 2003.

[21] Di Milia L. A psychometric evaluation and validation of the Preferences Scale. *Chronobiol Int*, 2005;**22**:679-93.

[22] Johns MW. A new method for measuring daytime sleepiness: The Epworth sleepiness scale. *Sleep* 1991;**16**:540-45.

[23] Johns MW. Reliability and factor analysis of the Epworth Sleepiness Scale. *Sleep* 1992;**15**:376-81.

[24] Cohen JA. A power primer. *Psychological Bulletin* 1992;**112**:155-59.

[25] Field A. *Discovering Statistics using IBM SPSS Statistics* (4th ed.). London: Sage Publications; 2013.

[26] Gould CE, Edelstein BA. Worry, emotion control, and anxiety control in older and young adults. *J Anxiety Disord* 2010;**24**:759-66.

[27] Robichaud M, Dugas MJ, Conway M. Gender differences in worry and associated cognitive-behavioral variables. *J Anxiety Disord* 2003;**17**:501-16.

[28] Kim H, Young T. Subjective daytime sleepiness: dimensions and correlates in the general population. *Sleep* 2005;**28**:625-34.

[29] Pilcher JJ, Ginter DR, Sadowsky B. Sleep quality versus sleep quantity: Relationships between sleep and measures of health, well-being and sleepiness in college students. *J Psychosom Res* 1997;**42**:583-96.

[30] Lund HG, Reider BD, Whiting AB, et al. Sleep patterns and predictors of disturbed sleep in a large population of college students. *J Adolescent Health* 2010;**46**:124-32.

[31] Fleeson W, Malanos AB, Achille NM. An intraindividual process approach to the relationship between extraversion and positive affect: is acting extraverted as" good" as being extraverted? *J Pers Soc Psychol* 2002; **83**:1409-22.

[32] LeBlanc M, Beaulieu-Bonneau S, Mérette C. Psychological and health-related quality of life factors associated with insomnia in a population-based sample. *J Psychosom Res* 2007;**63**:157-66.

[33] Steptoe A, O'Donnell K, Marmot M, et al. Positive affect, psychological well-being, and good sleep. *J Psychosom Res* 2008;**64**:409-15.

[34] Azevedo MH, Maia B, Marques M, et al. Psychometric properties of the Portuguese version of the Pre Sleep Arousal Scale. *J Sleep Res* 2010;**19**:157.

[35] Coren S. The arousal predisposition scale: Normative data. *Bull Psychon Soc* 1990;**28**:551-52.

[36] Coren S. Prediction of insomnia from arousability predisposition scores: Scale development and cross-validation. *Behav Res Ther* 1988*;***26**:415-20.

[37] Azevedo MH, Pereira A, Bos S, et al. *Characteristics of individuals vulnerable to sleep reactivity to stress*. Poster presented at 21st Congress of the European Sleep Research Society Paris, France; 2012.

[38] Fernández-Mendoza J, Vela-Bueno A, Vgontzas AN, et al. Cognitive-emotional hyperarousal as a premorbid characteristic of individuals vulnerable to insomnia. *Psychosom Med* 2010; **72**:397-403.

[39] Perlis M, Shaw P, Cano G, et al. (2011) Models of insomnia. In Kryger M, Roth T, and Dement W (eds). *Principles and Practice of Sleep Medicine* (5th ed). Elsevier Saunders. Missouri, 850-865.

[40] Brosschot JF, Van Der Doef M. Daily worrying and somatic health complaints: Testing the effectiveness of a simple worry reduction intervention. *Psychology and Health*, 2006;**21**:19-31.

[41] Kim K, Uchiyama M, Liu X, et al. Somatic and psychological complaints and their correlates with insomnia in the Japanese general population. *Psychosom Med* 2001;**63**:441-6.

[42] Walsh JK, Coulouvrat C, Hajak G, et al. Nighttime insomnia symptoms and perceived health in the America Insomnia Survey (AIS). *Sleep* 2011;**34**:997-1011.

Table 1. Sleep loss due to worry prevalence

Frequency	Total n (%)	Males n (%)	Females n (%)
Almost never	130 (18.2)	66 (26.9)	64 (13.7)
Few times	312 (43.8)	120 (49.0)	192 (41.0)
Many times	202 (28.3)	43 (17.6)	159 (34.0)
Almost always	35 (4.9)	4 (1.6)	31 (6.6)
Sleep loss due to worry (dichotomized)			
Yes [a]	237 (33.2)	47 (19.2)	190 (40.6)
No [b]	442 (62.0)	186 (75.9)	256 (54.7)
No response	34 (4.8)	12 (4.9)	22 (4.7)

[a]Yes = Almost never + Few times; [b]No = Many times + Almost always

Table 2. Group comparisons in psychological variables by sex

	Females	Males		
	M (SD)	M (SD)	*t* (df)	*p*
Arousal Predisposition	26.895 (5.961)	22.382 (5.796)	-9.606 (495.606)	<.001
Academic Stress	3.381 (.557)	3.002 (.624)	-7.683 (420.309)	<.001
Eysenck_Extraversion	2.698 (.402)	2.701 (.442)	.073 (424.028)	n.s.
Eysenck_Neuroticism	2.141 (.543)	1.956 (.558)	-4.119 (458.821)	<.001
NEO-PI-R_Neuroticism	123.327 (12.967)	116.750 (14.999)	-5.506 (393.853)	<.001
NEO-Anxiety (N1)	3.216 (.453)	2.948 (.462)	-7.156 (451.485)	<.001
NEO-Hostility (N2)	2.811 (.412)	2.710 (.417)	-2.976 (664.000)	<.01
NEO-Depression (N3)	2.850 (.615)	2.664 (.665)	-3.534 (439.687)	<.001
NEO-Impulsivity (N5)	3.138 (.407)	3.073 (.436)	-1.875 (440.138)	n.s.
NEO-Vulnerability (N6)	3.004 (.464)	2.767 (.520)	-5.809 (423.053)	<.001
Tendency to Worry	2.319 (.748)	2.026 (.723)	-4.957 (485.999)	<.001
Cognitive Arousal	19.451 (5.673)	18.747 (5.265)	-1.635 (520.989)	n.s.
Somatic Arousal	10.329 (3.417)	10.029 (2.962)	-1.208 (554.207)	n.s.
POMS_Fatigue/Inertia	1.383 (.853)	1.386 (.831)	.037 (474.832)	n.s.
POMS_Anger/Hostility	.704 (.585)	.731 (.675)	.544 (663.000)	n.s.
POMS_Negative Affect	.980 (.573)	.924 (.606)	-1.134 (428.729)	n.s.
POMS_Positive Affect	2.244 (.548)	2.409 (.581)	3.525 (428.022)	<.001
Expressive Supression	28.208 (5.290)	26.622 (5.398)	-3.633 (457.606)	<.001
Cognitive Reappraisal	13.717 (3.888)	15.192 (3.906)	4.598 (448.562)	<.001

Note. n.s. = not significant; df=degrees of freedom; M=mean; SD=standard deviation

Table 3. Group comparisons in health and sleep variables by sex

	Females	Males		
	M (SD)	M (SD)	t (df)	P
Physical Health	4.050 (.692)	4.120 (.743)	1.139 (462.011)	n.s.
Mental Health	3.890 (.737)	4.100 (.777)	3.381 (466.846)	<.01
Physical + Mental Health	3.974 (.612)	4.110 (.617)	2.773 (485.378)	<.01
Habitual Sleep Duration	3.890 (1.158)	3.850 (1.222)	-.419 (471.522)	n.s.
Sleep Depth	2.250 (.668)	2.000 (.676)	-4.751 (706.000)	<.001
Subjective Sleep Quality	2.260 (.722)	2.220 (.846)	-.624 (705.000)	n.s.
Sleep Needs	5.080 (1.308)	4.890 (1.488)	-1.716 (704.000)	n.s.
Sleep Flexibility	2.110 (.848)	2.140 (.884)	.466 (473.576)	n.s.
Sleep Latency	1.840 (.854)	1.730 (.862)	-1.752 (490.254)	n.s.
Nocturnal Awackenings	1.020 (1.178)	.670 (.977)	-3.995 (706.000)	<.001
Time to Get-up	1.320 (.572)	1.420 (.702)	1.966 (705.000)	n.s.
Mental Work	2.510 (1.148)	2.900 (1.289)	3.960 (675.000)	<.001
Physiological Timings	3.620 (.943)	3.740 (1.038)	1.461 (431.094)	n.s.
Morningness/Eveningness	2.190 (1.142)	2.384 (1.248)	2.082 (704.000)	<.05
Sleepiness Propensity	10.091 (5.279)	10.080 (5.171)	-.026 (488.434)	n.s.
Sleepiness Perception	1.356 (.538)	1.269 (.483)	-2.166 (528.732)	<.05
Quality of Sleep Index	1.844 (.616)	1.654 (.580)	-3.986 (704.000)	<.001
Sleep Loss due to Worry	2.35 (.81)	1.94 (.73)	-6.57 (677.000)	<.001
Insomnia	.110 (.313)	.100 (.305)	-.276 (482.148)	n.s.

Note. n.s. = not significant; df=degrees of freedom; M=mean; SD=standard deviation

Table 4. Associations among age, psychological variables and sleep loss due to worry

	Sleep loss due to worry
	r
Age	.091*
Arousal Predisposition	.491**
Academic Stress	.469**
Eysenck_Extraversion	-.115**
Eysenck_Neuroticism	.409**
NEO-PI-R_Neuroticism	.424**
NEO-Anxiety (N1)	.422**
NEO-Hostility (N2)	.299**
NEO-Depression (N3)	.377**
NEO-Impulsivity (N5)	.182**
NEO-Vulnerability (N6)	.330**
Tendency to Worry	.444**
Cognitive Arousal	.512**
Somatic Arousal	.349**
POMS_Fatigue/Inertia	.424**
POMS_Anger/Hostility	.267**
POMS_Negative Affect	.200**
POMS_Positive Affect	-.174**
Expressive Supression	n.s.
Cognitive Reappraisal	n.s.

* p<.05 ** p<.001

Note. n.s. = not significant

Table 5. Associations among health self-perception, sleep variables and sleep loss due to worry

	Sleep loss due to worry
	r
Physical Health	-.224**
Mental Health	-.320**
Physical+Mental Health	-.325**
Habitual Sleep Duration	-.081*
Sleep Depth	.285**
Subjective Sleep Quality	.283**
Sleep Needs	.101*
Sleep Flexibility	-.193**
Sleep Latency	.285**
Nocturnal Awackenings	.283**
Time to Get-up	n.s.
Quality of Sleep Index	.511**
Insomnia	.541**
Mental Work	n.s.
Physiological Timings	n.s.
Morningness/Eveningness	n.s.
Sleepiness Propensity	n.s.
Sleepiness Perception	.154**

* p<.05 ** p<.001

Note. n.s. = not significant

Table 6. Predictors of sleep loss due to worry

	B	Std. Error	β	t	p
Constant	-.011	2.66		-.040	.968
Predictors, R^2 = 40.3%					
Pre-sleep Arousal	.047	.005	.353	8.989	<.001
Academic Stress	.009	.004	.129	3.236	.005
Arousal Predisposition	.014	.006	.127	2.708	.006
Tendency to Worry	.166	.046	.153	3.634	<.001
Sex	.178	.061	.118	2.921	.001
Physical Health	-.097	.039	-.093	-2.468	.008