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Women's Sleep Disfunction is Predicted from Negative Affect

Disfunción del sueño de la mujer es predecida a partir del afecto negativo

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Abstract
Negative affect is increased with short sleep or sleep of poor quality and women have more sleep problems and experience more negative affect than men. We evaluated the hypothesis that sleep health is related to negative affect more strongly among women than men. Other hypotheses addressed positive affect and professions. Online surveys which included the Pittsburgh Sleep Quality Index were responded by 525 college students from four Peruvian universities. Sleep health was related to negative affect more strongly among women: whereas non-significant differences in negative affect were observed among men at two

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different levels of sleep dysfunction, women reported significantly greater negative affect if they were at the high level. Positive affect did not produce this type of result and professions did not moderate the relationships. We conclude that sleep health is related to negative affect more strongly among women than men. The findings suggest a need for exploring and treating depressive symptoms in women with sleep problems in clinical settings.

Keywords: Sleep functioning, sex, negative affect, positive affect, professions, Peru.

Resumen

La afectividad negativa aumenta con el sueño corto y/o de pobre calidad y las mujeres tienen más problemas de sueño y experimentan más afectos negativos que los hombres. En este estudio se evaluó la hipótesis de que la salud del sueño está relacionada a los afectos negativos más fuertemente entre las mujeres que entre los hombres. Otras hipótesis del estudio abordaron el afecto positivo y las profesiones. Una encuesta en línea que incluía el Índice de Calidad del Sueño de Pittsburgh fue respondida por 525 estudiantes de cuatro universidades peruanas. La salud del sueño emergió relacionada al afecto negative con más fuerza entre las mujeres: mientras que diferencias no-significativas fueron observadas entre los hombres a dos niveles diferentes de disfunción del sueño, las mujeres reportaron afectos negativos significativamente mayores si estaban en el nivel alto de disfunción. El afecto positivo no produjo este tipo de resultado y la profesión no moderó las relaciones. Se concluye que la salud del sueño se relaciona con el afecto negativo más fuertemente entre las mujeres que entre los hombres. Los hallazgos sugieren una necesidad de explorar y tratar síntomas depresivos en mujeres con problemas de sueño en servicios clínicos.

Palabras clave: Funcionamiento del sueño, sexo, afecto negativo, afecto positivo, profesiones, Perú.

Introduction

Sleep research has revealed important gender differences in sleep health: women experience more sleep problems than men (Anttalainen et al., 2007; Baranowski, & Jabkowski, 2023; Baughman et al., 2009; Bentley et al., 2006; Cubala et al., 2010; Fatima et al., 2016; Gabbay, & Lavie, 2012; Koo et al., 2008; Macey et al., 2012; Ohayo et al., 2014; Ralls et al., 2012; Subramanian et al., 2012; Wheaton et al., 2011; Zhang, & Wing, 2006). The present study is concerned with possible gender differences in the fact that, the more deficient the sleep, the higher the negative emotionality or negative affect (NA) experienced (Baglioni et al., 2010; Becker et al., 2020; Fairholme, & Manber, 2017; Goldstein, & Walker, 2014; Hamilton et al., 2008; Krause et al., 2017; Prather et al., 2013). NA items are «nervous», «scared», «afraid»,

«distressed», and «upset», among others (Tuccitto et al., 2010).

Affective states are significantly worsened by sleep deprivation (Babson et al., 2010; Baum et al., 2014; Cox et al., 2023; Gerhardsson et al., 2019), but only females tend to report anxiety and depression alongside other negative emotions (Eslaminejad et al., 2017). Salivary cortisol levels are increased in young women but not in men under sleep deprivation (Birchler-Pedross et al., 2009), suggesting sex differences in stress response modulation mechanisms. Furthermore, the presence of sleep problems and mental disorders as comorbidity to chronic pathological conditions are significantly more prevalent in women as compared to men (Bobo, 2016). And women suffer depression more frequently than men (Hyde, & Mezulis, 2020); more generally, women from normal populations have a greater susceptibility to NA than men not only in life settings (e.g. Borrachero et al., 2014) but also according to neuroimaging (Yuan et al., 2009). Since young adults often experience insufficient sleep quantity and poor sleep quality (Grandner, 2019), we targeted college students in the testing of **Hypothesis 1:** Sleep health is related to NA more strongly among women than men.

The observation that NA does not predict sleep duration or quality (Bouwmans et al., 2017) suggests that the reported negative relationship between sleep dysfunction and NA causally runs from sleep dysfunction to NA. Sleep dysfunction may cause NA as a reaction to the lack of repose or as a consequence of deficient repair and restoration processes of dysfunctional sleep, i.e., inadequate neuromodulation of the emotionally significant salient memories encoded throughout the day (Lefter et al., 2022). The processing of emotional memories occurs during REM sleep, a phase in which anxiety-promoting neurotransmitter activity is inhibited (Vyazovskiy, & Delogu, 2014; Walker, & van der Helm, 2009). This suggests that, in the case of women but not men, the repair and restoration processes of sleep fail to weaken the reactivity of negative emotionality in response to environmental or inner life stimuli.

In this perspective, the observed negative relationship observed between sleep dysfunction and positive affect (PA) (Bower et al., 2010; Difrancesco et al., 2021; Fredman et al., 2014; García et al., 2012; Ong et al., 2015; Sin et al., 2020) suggests a failure of the repair and restoration processes of sleep to promote the fixation of PA linkages in the networks of positive emotionality. Positive affect (PA) is defined by items such as "enthusiastic", «interested», «determined», «strong», and «excited», among others (Tuccitto et al., 2010). PA is typically highest during the daytime, while NA is highest during the nighttime (Sikka & Gross, 2023).

PA is involved in sex differences in personality. In the Big Five trait model of personality, Extraversion is associated with PA and Neuroticism with NA (Verduyn, & Brans, 2012). Higher scores in Extraversion and lower scores in Neuroticism have been reported for men than women in cross-cultural studies of the traditional lexical traits

(Costa et al., 2001) as well as considering implicit self-concepts (Vianello et al., 2013). Regarding the more specific Big Five Aspect Scales - two per trait -, men have exhibited more Enthusiasm and Assertiveness (Extraversion) and less Withdrawal and Volatility (Neuroticism) than women (León et al., 2017). In Cloninger's model of seven dimensions of personality (Cloninger et al., 1998), Novelty Seeking is associated with PA and Harm Avoidance with NA (Laricchiuta et al., 2014); sex differences for the two traits have recently been reported in the expected directions (Eley et al., 2023).

Whereas the literature indicates that short and poor sleep tend to be associated with lower PA, the evidence is importantly contradictory (Ong et al., 2017). Particularly informative is a study which showed significant relationships between poor sleep and PA and NA (Bower et al., 2010); when the authors accounted for the relationship between sleep and NA, PA became unrelated to sleep. This points to the possible existence of spurious sleep-PA relationships which owe to effects of NA on PA. In the early research, the affect variables were assumed to be uncorrelated, but it has been shown that they tend to be related (Larsen et al., 2017), especially under state measurements, i.e., when recent, short-term emotions are targeted (Schmuckle et al., 2002) (e.g. «Did you feel a lot of enthusiasm this morning?»). PA and NA tend to emerge uncorrelated when dispositional affect is measured, i.e., when questionnaire items refer to the occurrence of specific emotions along extended time periods. By analogy with the case of NA, gender can be expected to moderate the relationship between sleep dysfunction and PA. Taking the above-mentioned complexities into account, the present research utilized measurements of emotions which minimize the PA-NA correlation by targeting accounts of emotionality for the last four weeks; additionally, NA was controlled as we tested **Hypothesis 2:** Sleep health is related to PA more strongly among men than women.

The Type D personality is described as the tendency to experience a high joint occurrence of NA and social inhibition (Denollet, 2000; Mols, & Denollet, 2010) and is associated with increased sleep problems (Akram et al., 2018; Condén et al., 2013). The Type D personality contributes to the high prevalence of burnout in health professionals (Van den Tooren, & Rutte, 2016) as well as their lower mood (Gieniusz-Wojczyk et al., 2020). However, working conditions may alternatively be held responsible for the burnout and lower mood of health professionals (Glebocka, 2017). Since students of these professions are not particularly exposed to negative working conditions, we tested **Hypothesis 3:** Hypotheses 1 and 2 will show validity among students of a health profession to a greater extent than among students of non-health professions.

Methods

Participants

College students from four Peruvian universities accepted to participate in a survey about sleep and emotions (N= 525). The response rate was 71%. Data

collection occurred from November 1st to 30th, 2022 at three universities and from March 1st to 30th, 2023 at the fourth one. Two universities operated only in Lima and two had campuses in several provinces in addition to Lima. The students were enrolled in nutrition (N= 186), administration, finance, marketing, or law (N= 131), engineering careers (N= 95), and economics or organizational psychology (N= 113).

Measures

Pittsburgh Sleep Quality Index (PSQI). The PSQI, one of the most frequently utilized sleep questionnaires, yields seven component scores referred to the past four weeks: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction (Buysse et al., 1989). The total score, which represents the extent of sleep dysfunction, was targeted for analyses in the present study. The version utilized was a Spanish translation validated in Peru (Luna-Solís et al., 2015).

Positive and negative affect. This checklist stemmed from the Short Version of 20 items of the Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988). A Spanish version validated in a Peruvian college population was utilized (Gargurevich, & Matos, 2012). The reference was to the strength of emotions in the past four weeks and considered five levels, from «Nothing» (1) to «A lot» (5). The sum of PA scores (ten items) and the sum of NA scores (ten items) were targeted for analysis.

Profession. We distinguished between health (nutrition) and non-health professions.

Index of Healthy Eating (IHE). Sleep is influenced by the food ingested (Crispim et al., 2017); therefore, the food variable needed control. Inputs for the IHE were responses about the daily, weekly, or occasional eating of specific foods. Positive scoring was assigned to daily eating of cereals, dairy products, vegetables and greens, and fruits; weekly consumption of legumes and meats (including eggs and fish); and occasional use of sausages and cold cuts, sweets, and sugary drinks (Norte Navarro. & Ortíz Moncada, 2011).

International Physical Activity Questionnaire (IPAQ). Sleep also depends on the level of physical activity (Kakinami et al., 2017). The short version of the IPAQ includes seven questions about activities of the past seven days. The measurements referred to the intensity, frequency, and duration of physical activity and were expressed as metabolic repose units per minute/week (Mantilla-Toloza, & Gómez-Conesa, 2007).

Other measurements. Evidence of relationships between sleep health and age (Schwarz et al., 2017), Body Mass Index (Krističević et al., 2018), cycle of studies (Manzar et al., 2015), academic workload outside classes (Yangdon et al., 2021), family earnings (Seo et

al., 2017), use of electronic devices in bed (Pham et al., 2021), drinking alcohol (Strein & Friedmann, 2006), and drinking coffee at nighttime (Clark, & Landolt, 2017) indicated a need for treating these variables, too, as confounders. Hence, data on age, Body Mass Index, cycle of studies (two per year), academic workload outside classes (in hours), family earnings (six levels), use of electronic devises in bed (Yes= 1, No= 0), alcohol use (five levels), and drinking coffee at nighttime (five levels) were collected.

Procedure

The participants were invited by e-mail to fill in the study questionnaire. Those who accepted utilized an electronic link to provide their responses. The participants' informed consent form had been approved by Universidad .... as part of its Ethics Committee project approval dated December 18th, 2020 (Constancia No. 660-01-20).

Data Analysis

All analyses were conducted using IBM SPSS 23. To be able to depict sex x sleep interactions, we dichotomized sleep dysfunction scores at the median and treated sex and the sleep dysfunction and profession dichotomies as factors in general lineal models.

Results

Table 1 presents correlations between selected study variables. They were significant, excepting the NA-PA correlation, which only achieved borderline significance (r= .08, p< .059), and the sleep dysfunction-profession r. In terms of Cronbach's alpha coefficient, the reliability of the composite scores was generally acceptable: sleep dysfunction= .60, PA= .84, NA= .90, healthy food= .64. and physical activity= .78.

Table 1.
Correlations between selected study variables.

	Variables	1	2	3	4	5
1	Sleep Disfunction	-				
2	Sex	-.13 (.002)	-			
3	Profession	-.06 (.145)	.24 (< .001)	-		
4	Positive affect	-.17 (< .001)	.17 (< .001)	.19 (< .001)	-	
5	Negative affect	.47 (< .001)	-.16 (< .001)	-.14(.001)	.08 (.059)	-

Note. Significance is among parentheses. N= 525.

Results of the general linear model analysis pertaining to NA are shown on Table 2. Hypothesis 1 was upheld by the evidence. Regardless of the use of confounders in the equations, the effects of sex, sleep dysfunction, and sex x sleep dysfunction emerged significant.

Table 2.

Main and interactive effects of sex, sleep disturbance, and profession on negative affect without (Model 1) and with (Model 2) control upon possible confounders.

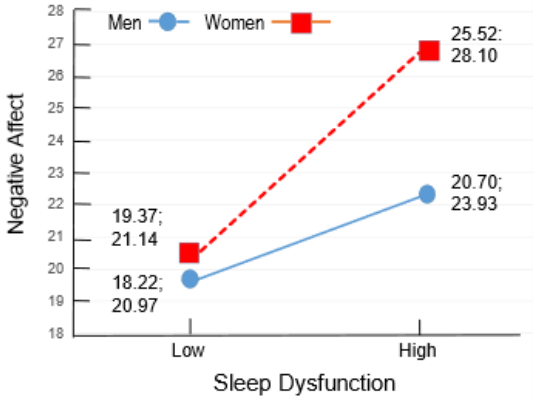
	Model 1			Model 2		
	F	***p***	**Partial Eta2**	**F**	***p***	**Partial Eta2**
Sex (women = 1, men = 2)	13.04	<.001	.025	17.79	<.001	.034
Sleep disfunction	40.22	<.001	.072	40.82	<.001	.075
Profession (health = 1, non-health = 2)	0.86	.355	.002	2.81	.094	.003
Sex x sleep disfunction	7.06	.008	.013	7.72	.006	.015
Sex x profession	3.61	.058	.007	5.67	.017	.011
Sleep disfunction x profession	4.37	.037	.008	3.11	.078	.006
Sex x sleep disfunction x profession	3.16	.076	.006	2.14	.144	.004
Age				1.31	.252	.003
Body Mass Index				2.19	.139	.004
Healthy eating				4.88	.028	.010
Physical activity				0.98	.324	.002
Academic cycle				0.01	.940	.000
Workload outside class				3.91	.049	.008
Electronic device in bed				10.21	.001	.020
Alcohol use				0.39	.534	.001
Coffee at night				0.09	.759	.000
Family income				10.46	.001	.020
Positive affect				24.75	<.001	.047

Note. N= 525.

Figure 1 depicts significant interactive effects on NA under Model 2; similar were the effects under Model 1. Whereas non-significant differences were observed between men and women at the low level of sleep dysfunction, women significantly outperformed men at the high level. Fig. 2 depicts the second significant interaction. The cross- over of the means is noteworthy. Among the confounders, PA and sex presented the strongest impacts on PA.

Figure 1.

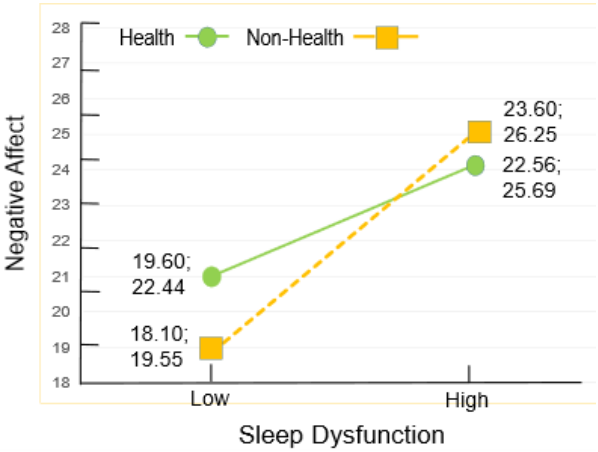
Estimated means and their 95% confidence intervals for negative affect scores depicting significant sex x sleep dysfunction interaction with control exerted upon likely confounders.



Different was the case of PA (Table 2). Contradicting Hypothesis 2, none of the interactions reached significance. The main effects of sleep dysfunction, sex, and profession were significant across models reflecting, respectively, greater PA (a) among men than women, (b) at the low than the high level of sleep dysfunction and (c) among non-health professions than health professions. Among the confounders, NA and sex presented the strongest impacts on PA.

Figure 2.

Estimated means and their 95% confidence intervals for negative affect scores depicting significant profession x sleep dysfunction interaction with control exerted upon likely confounders.



Hypothesis 3 was not upheld by the evidence. Greater effects of the sex x sleep dysfunction interaction on NA or PA failed to emerge among students of a health profession compared to students of non-health professions.

Table 3.

Main and interactive effects of sex, sleep disturbance, and profession on positive affect without (Model 1) and with (Model 2) control upon possible confounders (N = 525).

	Model 1			Model 2		
	F	***p***	**Partial Eta2**	**F**	***p***	**Partial Eta2**
Sex (women = 1, men = 2)	0.95	.002	.018	22.89	<.001	.043
Sleep disfunction	4.84	.028	.009	7.44	.007	.014
Profession (health = 1, non-health = 2)	0.79	.005	.015	9.59	.002	.019
Sex x sleep disturbance	0.53	.468	.001	1.29	.256	.003
Sex x profession	0.64	.426	.001	1.60	.207	.003
Sleep disturbance x profession	0.01	.937	.000	0.40	.533	.001
Sex x sleep disturbance x profession	0.53	.468	.001	0.59	.443	.001
Age				0.12	.726	.000
Body Mass Index				0.99	.321	.003
Healthy eating				12.76	<.001	.025
Physical activity				8.02	.005	.016
Academic cycle				0.79	.375	.002
Workload outside class				11.66	<.001	.023
Electronic device in bed				7.97	.005	.016
Alcohol use				0.85	.357	.002
Coffee at night				2.23	.136	.004
Family income				5.12	.024	.010
Negative affect				24.75	<.001	.047

Discussion

As expected in Hypothesis 1, sleep health emerged related to the experience of NA more strongly among women than men. More specifically, whereas non-significant differences in NA were observed among men at two different levels of sleep dysfunction, women reported significantly greater negative affect if they were at the high level. On the other hand, the responses of the study participants, contradicting Hypothesis 2, revealed a reported PA that was insensitive to any sex x sleep dysfunction interaction despite the significant main effects of sex and sleep dysfunction that were observed. Indeed, PA emerged significantly reduced with increased sleep

dysfunction equally in men and women and this occurred regardless of NA level. The finding suggests that the priority objective of sleep's repair and restoration functions regarding PA is the fixation of connections within the positive emotionality network in memory. PA would have been reduced in the high sleep disfunction condition both among women and men of this study due to a failure of sleep to complete such functions. In contrast, the observed sex x sleep dysfunction interaction regarding NA suggests that the repair and restoration functions of sleep do not apply to NA similarly among men and women. It would appear that, during REM sleep, a phase in which anxiety-promoting neurotransmitter activity is inhibited (Vyazovskiy, & Delogu, 2014; Walker, & van der Helm, 2009), NA has a special ability to attract sleep processes leading to its modulation in a way that limits retrieval. Why such processes hypothetically fail to be completed under sleep dysfunction to a greater extent among women than men remains a challenging question.

Hormonal processes and brain structure may provide answers. The main differences between men and women are hormonal. Female sex hormones promote wakefulness and suppress sleep (Dorsey et al., 2021). The role of hormones in sleep is insufficiently known, but there is evidence that women exhibit different sleep architectures during the different stages of their ovulatory cycle (Romans et al., 2015). This suggests that progress in scientific knowledge about effects of the sex x sleep dysfunction interaction on NA can eventually be achieved through comparisons of women at different stages of their ovulatory cycle. Another major sex difference involves brain structure and functioning; women have greater connectedness between the two hemispheres of the brain (Ingalhalikar et al., 2014). Future research on activation of brain areas can be expected to throw light upon the NA effects of the sex x sleep dysfunction interaction. On the other hand, the research indicates that variations in dopamine underlie PA experiences whereas variations in serotonin and norepinephrine underlie variations in NA (Gu et al., 2019). This suggests that neuropsychological processes involving dopamine function similarly in men and women; this would not be the case of processes involving serotonin or norepinephrine.

The practical applications of the present findings are straightforward. Health providers providing services to women with sleep problems should ask whether such problems are associated with negative emotionality to an extent that justifies specific treatment. Vice versa, health providers providing services to women with problems of negative emotionality should ask whether such problems are associated with sleep dysfunctions to an extent that justifies specific treatment.

The expected sex x sleep dysfunction x profession interactive effects on NA or PA failed to emerge. Health students exhibited greater NA than students of non-health professions and the respective

sleep dysfunction x profession interaction achieved significance, but the interaction was attributable to the cross-over of the means; the NA difference observed between health and non-health students was not significant, neither at the low level of sleep dysfunction nor at the high level.

Whereas all reported results of a study need replication to become scientific evidence (Zwaan et al., 2018), this is particularly the case of the main result of the present research – the interactive effect of sex and sleep dysfunction on NA observed - considering its nature of single original observation in the literature. Regarding the external validity of the finding, it will be necessary to study whether younger and older populations present the same relationship observed among young adults. This type of research could help to differentiate the roles of hormones versus brain structure. Also, there are studies in which shorter sleep was more specifically associated with lower positive emotions whereas sleep of poor quality showed stronger associations with negative affect (Shen et al., 2018). Addressing the two dependent variables may provide finer results.

Limitations

Conclusions about cause-effect relationships are not justified by the study design. A longitudinal study with repeated measurements of sleep dysfunction («How did you sleep last night») and state affect («How did you feel today») would have been required for asserting that bad sleep anteceded NA. The study incurred in important limitations as a result of the attempt to maintain PA and NA uncorrelated, which was unsuccessful anyway: PA and NA were the strongest confounders in the general linear model analyses, indicating a failure of our design efforts to maintain independence between the two affect variables. The temporal framework for the PANAS checklist was the past four weeks, not today. Since the temporal framework of the sleep dysfunction measurements was also four weeks, this implicated a long-term correlation between sleep dysfunction and NA that made undistinguishable the direction of causality. Moreover, the force of NA was addressed in the study to maintain the instructions of the PANAS form validated in Peru. This is one way of measuring NA (Cloos et al., 2023), but the frequency of the emotional event was not addressed. These limitations should be overcome in constructive replications of the study.

Another limitation that should be overcome in future studies is the failure to address the dreamworld. Respondents were assumed to interpret the instructions of the PANAS in reference to the wakeful state. The NA and PA contents of dreams during REM may bring information capable of clarifying the underlying processes.

Conclusions

First: Sleep health is related to the experience of NA more strongly among

women than men. Second: Sleep health is related to the experience of PA similarly in women and men. Third: Profession does not moderate the relationships involving sleep dysfunction and NA.

Fourth: Simple and constructive replication studies are needed.

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Conflicting interests

The Authors declare that there is no conflict of interest.

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