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Original Research

Sedentary behaviour in college students and its influence on heart rate and mental health

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Abstract: Objective: To determine the relationship between sedentary lifestyle in university students and its relationship with physiological and psychological variables. Methods: This is a descriptive cross-sectional study, carried out in a sample of 376 university students belonging to the Teruel campus. The following variables were collected by means of questionnaires: anxiety, stress and sitting hours, and resting heart rate (HR) was measured. A correlation matrix using Pearson's coefficient in a linear regression model was used to test the association between variables. Results: Increased time in a sedentary position was related to increased levels of stress ($p<0.001$) and resting heart rate ($p=0.014$) independently of age. In addition, anxiety and stress also find a significant association($p<0.001$). Higher self-perceived anxiety is related to higher stress levels. Only in those under 23 years of age is there a positive correlation between self-perceived anxiety and heart rate. That is, the higher the anxiety the higher the heart rate. Conclusions: The study showed that spending more time in a sedentary position generates negative consequences on students' health, such as increases in stress levels or resting heart rate, which could become an indirect risk of cardiovascular disease.

Keywords: sedentary behavior, physical activity, anxiety, heart rate, stress, sitting hours.

1. Introduction

. There is growing evidence linking a sedentary lifestyle to the risk of health problems (Bull et al. 2020). This may include cardiovascular diseases such as type 2 diabetes, hypertension (Zhai, Zhang, and Zhang 2015) or even depressive episodes (Rodriguez-Ayllon et al. 2019). People who have sedentary jobs face both musculoskeletal and cognitive problems, which is considered a growing concern for today's society (Compernolle et al. 2019). Leading an active lifestyle can mitigate these adversities, as physically active people tend to have better physical and mental health, as well as psychosocial well-being (Silveira et al. 2022).

One of the ways to objectively measure how sedentary a person is is the number of hours spent sitting during the day (Tremblay 2012). Dutta et al. (2014) compared sitting with standing for several workdays and found that the more static position resulted in greater fatigue and lower self-rated energy level, as well as lower concentration and

productivity. Similarly, Baker et al. (2018) observed a deterioration in creative problem-solving errors over time and a negative impact on mental state when prolonged sitting exceeded ninety minutes.

Therefore, it seems clear that sedentary behavior could have a negative impact on the mental health of the population (Walsh et al. 2011). Similarly, reduced physical activity could also have an impact, as it has been linked to increased risk of depression (Zhai, Zhang, and Zhang 2015) and anxiety (Belair et al. 2018). These disorders, along with stress, are considered critical indicators of mental health (Ramón-Arbués et al. 2020). However, the impact of other factors that may influence the aforementioned psychological variables should be taken into consideration. Studies such as that of Cai et al. (2022) show contradictory results, as socioeconomic conditions, personal relationships and/or health status may also exert influence. Thus, any connection between sedentary behavior and these psychological factors could be attributed to these confounding variables.

The vast majority of mental health disorders emerge in early adulthood (Gao et al. 2020).

Similarly, it should be noted that both sedentary behavior and psychological disorders can induce physiological manifestations (s et al. 2011). Acute mental stress can lead to increased muscle tension, intensified respiratory rate and accelerated heart rate (Schiweck et al. 2019). Similarly, in the face of a generalized episode of anxiety, increases in hyperventilation may be observed with a consequent increase in heart rate (Pittig et al. 2013).

Additionally, there is sufficient evidence supporting the presence of several adverse cardiovascular health effects associated with sedentary behavior (Lavie et al. 2019). In fact, the American Heart Association highlighted its connection to cardiovascular disease morbidity and mortality, including hypertension, heart failure, and atherosclerosis as the most common (Young et al. 2016).

In the specific case of sedentary patients experiencing depressive symptoms and metabolic syndrome, they exhibit an above-average heart rate, which may not be directly linked to the depression itself (Carnevali et al. 2018). In addition, prolonged sitting may cause in a decrease in stroke volume, triggering a response in the autonomic nervous system that is reflected in an increase in heart rate (HR) as a compensatory mechanism to preserve cardiac output (Shaffer, McCraty, and Zerr 2014). However, Bates et al. (2021), in their meta-analysis on regular exposure to sedentary behaviors, conclude that there are no significant differences with respect to increased heart rate and that the findings of the current publications are inconsistent and with low statistical power. Therefore, it is considered of interest to carry out further research to clarify this issue in greater depth.

Despite some inconsistency in research findings, there appears to be a relationship between psychological disorders, such as anxiety and stress, and physiological variables, such as heart rate, which may also exhibit links to lifestyle. This work focused on university students, given their predisposition to elevated levels of stress, anxiety and depression compared to other populations of different ages (Bayram and

Bilgel 2008), as well as their propensity to adopt behaviors with low physical activity (Bernardes, Yamaji and Guedes 2015). The aim of the present study is to determine the relationship between sedentary lifestyles in college students with heart rate, stress and anxiety.

2. Materials and Methods

A sample of 371 university students was recruited from the degrees in fine arts, nursing, psychology, child teaching and primary school teaching at the Teruel Campus of the University of Zaragoza. However, three of them were excluded from the analysis because they did not complete at least 50% of the questionnaires. The ages ranged from 18 to 40 years, and were divided into a total of 299 women (22.5±3.95) and 72 men (22.0±2.89). The sample size was calculated using EPIDAT 3.1, considering an expected standard deviation of 100 and a confidence interval of 95%. A non-probabilistic random sampling method was used to select the participants.

A defined protocol was followed to avoid variability in data collection. The variables under study were collected in person and through self-reported forms.

The level of physical activity of the subjects and the hours they remained seated during the week were measured by means of the short version of the validated IPAQ questionnaire translated into Spanish (Craig et al. 2003). This model consists of 4 generic items classifying the level of physical activity as high, moderate, or low according to the number of METs expended per week. The scores vary between <5,000 as sedentary or low style and >12,500 as active subject. One of the items quantifies the exact time spent in a sedentary position without accounting for hours of nighttime sleep.

Stress management was recorded through one of the six dimensions that make up the HPLP-II health promotion questionnaire (Walker, 1990). This has 8 items and divides the subjects between very poor and good stress management according to the score obtained, with the highest value being indicative of better stress management.

Finally, the Spanish version of the Beck Anxiety Inventory (BAI) (Anon n.d.) was used for the level of anxiety. This questionnaire consists of 21 items that reflect the severity of anxiolytic symptoms. Respondents rated it on a Likert scale from 0 to 3, dividing the sample according to the score obtained. The number ranges from 0, considered as low, to 63 as high.

A pulse oximeter placed on the index finger of each participant was used to record heart rate. The measurement lasted approximately ten minutes.

This study was approved by the Ethics and Research Committee of the Autonomous Community of Aragón (CEICA), in accordance with the ethical principles established by the Declaration of Helsinki.

Participation in the study was voluntary and all subjects gave their consent by signing the informed consent form after being instructed by the principal investigator of the objective of the study. The rights of the participants in relation to the protection of personal data and guarantee of digital rights collected in the Organic Law 3/2018 of December 5 were guaranteed.

Data analysis was performed using the Jamovi 2.3.21 statistical program. A descriptive analysis was performed using the mean and standard deviation. In addition,

the normality of the data was tested using a Shapiro-Wilk test and the homogeneity of variances with Levene's test. Most of the variables did not have a normal distribution, so nonparametric data analysis models were used. To test the association between the study variables, a correlation matrix was performed using Pearson's coefficient in a linear regression model between heart rate, sitting hours, anxiety and stress management. The significance criterion used was $p<0.05$.

3. Results

Table 1 shows the variables categorized according to gender and academic major.

The results of this research are presented in two parts.

On the one hand, Table 2 shows a global correlation matrix by dispersing the data among the dependent variables of the study. In this analysis, it was observed that a greater number of hours of sitting was associated with better stress management and an above-average heart rate. On the other hand, an inverse correlation was observed between anxiety and stress management. In this context, significance was high, indicating that higher levels of anxiety corresponded to higher levels of stress.

Table 1. General characteristics of the participants.

Grade	Sex	Total (N = 371)	Mean	SD
Nursing	women	80	155	139.4
	men	21	206	150.4
Psychology	Women	67	177	127.9
	men	17	239	127.4
Child teaching	Women	66	175	38.67
	Men	21	182	62.04
Primary school teaching	Women	35	287	61.43
	men	7	191	116.75
Arts	women	51	204	79.61
	men	6	213	116.6

Note. Categorical variables (i.e., grade, gender) are reported as percentage. SD = standard desviation

Table 2. Correlation matrix between study covariables.

		Total (N = 371)			
		HR	*Seated hours*	*Stress Management*	*Anxiety*
HR	Pearson's r	-			
	p-value	-			
Seated hours	Pearson's r	0.138	-		
	p-value	0.008**	-		
Stress Management	Pearson's r	-0.065	-0.171	-	
	p-value	0.215	<0.001***	-	
Anxiety	Pearson's r	0.086	0.046	-0.270	-
	p-value	0.097	0.373	<0.001***	-

Note. HR = Heart Rate

[a] *Significance level from correlation analysis by dispersing the data among the dependent variables. *p <0.05, **p < 0.01. ***p< 0.001*

Tables 3 and 4 reflect the correlation matrix segmented by age. Table 3 presents the participants under 23 years of age, where significance was obtained for the same variables as in the previous analysis, as well as for heart rate and anxiety. Perceiving

higher levels of anxiety produced an alteration in heart rate levels above the mean. In contrast, Table 4 shows subjects older than 23 years, who only found significance in the inverse relationship between anxiety and stress management.

Gender was taken into account as a possible confounder. However, no significant result was found, so it was not incorporated in the analysis.

Table 3. Correlation matrix study covariables. Under 23 years of age

		Total (*N* = 283)			
		HR	*Seated hours*	*Stress Management*	*Axiety*
HR	Pearson's r	-			
	p-value	-			
Seated hours	Pearson's r	0.160	-		
	p-value	0.007**	-		
Stress Management	Pearson's r	-0.120	-0.194	-	
	p-value	0.044*	0.001**	-	
Anxiety	Pearson's r	0.108	0.041	-0.264	-
	p-value	0.069	0.488	<0.001***	-

[a] *Significance level from correlation analysis by dispersing the data among the dependent variables. *p <0.05, **p < 0.01. ***p< 0.001*

Table 4. Correlation matrix study covariables. Over 23 years of age

		Total (*N* = 88)			
		HR	*Seated hours*	*Stress Management*	*Anxiety*
HR	Pearson's r	-			
	p-value	-			
Seated hours	Pearson's r	0.140	-		
	p-value	0.194	-		
Stress Management	Pearson's r	0.112	-0.097	-	
	p-value	0.300	0.370	-	
Anxiety	Pearson's r	0.046	0.023	-0.288	-
	p-value	0.674	0.828	0.007**	-

[a] *Significance level from correlation analysis by dispersing the data among the dependent variables. *p <0.05, **p < 0.01. ***p< 0.001*

4. Discussion

The purpose of this article was to discern the relationship between sedentary lifestyle in university students and its relationship with heart rate, as well as psychological variables such as anxiety and stress, and whether this has an impact on their general health status. Our data corroborate the relationship of these variables with sedentary lifestyle.

The results of the present study showed a positive correlation between the number of hours sitting and increased stress levels. This finding supports previous research such as that of Teychenne, Costigan, and Parker (2015), who argue that time spent sedentary can influence emotional and mental health, regardless of age. Or work such as that of Lee and Kim (2019) with a sample of 244 college students, conclude that as subjects spend more time sitting, their levels of stress and depression increase. However, in this research, anxiety showed no association with hours of sitting. This could be explained by the fundamental influence of the prevailing climate and the social interactions inherent in these environments, factors that have not

been considered. Studies such as those by Tomás-Miquel, Expósito-Langa and Nicolau-Juliá (2016) highlight the importance of relational factors in students for their academic performance and psychological well-being. Therefore, it seems plausible that the social environment may influence the self-perception of psychological factors such as anxiety.

Additionally, this research evidenced that spending more hours in a sedentary position produced an increase in resting heart rate (HR). This is in agreement with recent studies such as Dempsey et al. (2020), which state that an increase in resting heart rate may be closely related to cardiovascular disease and sedentary lifestyle. However, a recent meta-analysis on heart rate and its association with a sedentary lifestyle includes articles with low statistical power (Alansare et al. 2021). Furthermore, a stronger association between sedentary lifestyle and heart rate was found in men, but not in women. This disparity may be explained by differences in autonomic control of the heart, given that women have the lowest vagal activity (Koenig and Thayer 2016). Therefore, the impact of sedentary behavior on heart rate could be lower in women than in men. In contrast, no difference between genders was found in this study.

In conclusion, it can be established that a lifestyle with a more sedentary component can lead to health problems, such as elevated resting heart rate, associated with increased cardiovascular risks, and increased stress levels, which is also related to these cardiovascular diseases (McNeely 2005) and lower cognitive function (Karimi, Adel-Mehraban, and Moeini 2018), which can result in reduced academic performance.

On the other hand, it was considered interesting to perform an age segmentation of the sample, since Viner and Booy (2005) concluded that younger students presented a higher number of depressive episodes, stress and anxiety compared to other older populations. In this case, a relevant correlation between the variables was found only for the younger participants. In addition to finding significance between HR and anxiety, which was not obtained in the analysis of the overall sample. This last finding follows the line of research such as that of Noteboom, Barnholt and Enoka (2001), who point to anxiety as an emotional response that causes increases in blood pressure and HR, and that this is accentuated in younger subjects. However, those older than 23 years did not exhibit statistical significance with any of the previously mentioned correlations. This phenomenon could be attributed, according to the study by Hernández Zamora Zoila & Pedraza Romero Enrique (2010) to the availability of time and autonomy to carry out the activities of their preference. In contrast, young people operate in a context characterized by constant academic pressure, derived from factors such as exams and workload, lack of free time or worries about not meeting parental expectations (Vijay Mahadeorao Bhujade 2017). Therefore, these results support the hypothesis of a greater influence of psychological factors in the university population compared to the adult population.

5. Practical Applications.

Thus, it is recommended to reduce the time spent sitting throughout the day, with the aim of attenuating the possible psychological and physiological problems associated and that can reduce the level of health and well-being of students. This population remains seated for prolonged periods of time, so strategies such as interrupting sitting may achieve additional improvements compared to not doing so. Health Departments such as Canada (Ross et al. 2020) recommend this type of strategy, since health risks can be significantly reduced.

Limitations of the study include the possibility of response bias in the completion of the forms. Participants may interpret the items subjectively and this may influence the final result. In addition, when segmenting by sex, no significant results were found, which may be explained by the difference in the sample between men and women, with the sample of men being considerably smaller than that of women.

For future research, it is recommended that higher quality experimental studies be carried out, with the aim of clarifying to a greater extent the relationship between the variables mentioned in the study. In addition, it is important to take into account other factors such as social relations or socioeconomic level for a holistic understanding and better interpretation of the results.

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