International Journal of Community Medicine and Public Health
Agbaraolorunpo FM et al. Int J Community Med Public Health. 2024 Feb;11(2):625-633
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20240247

Original Research Article

Cognitive hallmarks of insomnia and its influence on cardiac response to handgrip test among medical students

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Received: 13 November 2023
Revised: 17 December 2023
Accepted: 19 December 2023

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ABSTRACT

Background: Sleep disturbance, particularly insomnia, is increasingly prevalent among university students, and is associated with risk of cardiovascular disease in general population. The study investigated predictors of insomnia and its impact on cardiovascular responsiveness among undergraduates at the University of Lagos, Nigeria.
Methods: A cross-sectional survey was conducted on 514 students categorized into normal or insomnia groups based on their insomnia severity index (ISI) scores. The association between insomnia and various factors related to poor sleep was assessed. Systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) responses to a handgrip test at 30% maximum voluntary contraction (MVC) were compared between the two groups (n=57) using t-tests.
Results: Predictors of insomnia among students included environmental discomfort, engagement in digital activities, emotional and health challenges, use of sleep suppressants, and academic stress, all significantly associated with insomnia ($p<0.001$). Other factors associated with insomnia included low mood, attention deficit, memory loss, and poor academic performance ($p<0.01$). Average SBP and DBP were significantly higher ($p<0.05$) in control group compared with insomnia group.
Conclusions: Low mood, attention deficit, memory loss and poor academic performance are hallmarks of insomnia among medical students, with no potential cardiovascular risk.

Keywords: Academic performance, Cardiovascular risk, Insomnia, Sleep disturbance

INTRODUCTION

Insomnia, characterised by inability to initiate and maintain sleep, is the leading form of sleep disorders, with the figure standing at 32.6% according to a data obtained from studies in 10 nations.[1-3] This figure is comparable to the prevalence ranges between 9.4% and 38.2% as reported in a systematic review of studies from a couple of universities, and supported by a recently reported prevalence of 10.6% among University students in Nigeria.[4,5] As it stands, it was recently reported that university students sleep less than the normal sleeping hours of 7 to 9 hours per day recommended for them.[6] As such, insomnia has been viewed as a public health challenge requiring appropriate attention among this critical population.[7]

Most importantly, the implication of poor sleep is incredibly distressing, as it is reported to engender daytime drowsiness, weakened memory capacity and impairs cognitive function, while hampering learning ability and engendering academic failure.[8] Similarly, studies from high- and low-income nations have shown that insomnia adversely take toll on work performance, social relationships and health outcomes.[9]

Although investigation related to sleep is gaining traction among student population, there is paucity of data

regarding predictors of insomnia among students from developing countries. In the same vein, there are conflicting findings regarding cardiovascular adjustment to poor sleep, with some study is demonstrating remarkable responses, while other show no responses.[10,11] Therefore, this study attempts to narrow this existing knowledge gap by providing data from student in a medical school from Lagos City, Nigeria.

METHODS

Study design and location

The study was a descriptive and experiment designs conducted between January and July of 2023 at the College of Medicine of the University of Lagos, Idiaraba, Lagos, Nigeria among undergraduate students faculty of basic medical sciences, clinical sciences, and pharmaceutical sciences.

Sampling methodology

Convenient sampling was adopted in selecting the participating students invited from the participating faculties. Sampling size was calculated as $n = z^2pq/d^2$, with (p) taken as the average of previously reported prevalence of insomnia (p) standing around 40%, in a systematic review study of insomnia across universities, d was set at 5% for critical value with confidence interval of 95% as 1.96 representing z, while q was the compliment of p (1-p). After adding a non-responsive rate of 40% to the sample size, the final sample size obtained was 518.

Data collection

Self-administered questionnaires were given to students who accepted to participate in the study after they have signed relevant informed consent forms. The questionnaire was designed to obtain demographic information of the participants. Information on sleep pattern, sleep disturbance and associated related factors surrounding their sleep in the last 3 months were also obtained, followed by the assessment of their sleep disturbance score using the insomnia severity index. To participate in the study the participants must be a registered medical student resident on the University campus.

Assessment of insomnia using insomnia severity index

Insomnia severity index (ISI) is a valid and reliable psychometric tool to evaluate the perception of an individual insomnia over a period of 3 months. Each item of ISI tool is scaled on a 5-point Likert scale from 0 to 4, with the score ranging from 0 to 28. Individuals with score ≥15 were classified as insomnia group, while those with less scores represented the normal group.[12]

Assessment of academic performance, prevalence and covariances of clinical insomnia

Using the Likert scale assessment responses, graded between 0-4 responses, information was obtained from participants regarding their environmental comfortability, use of digital devices prior to sleep, health-related and emotional challenges, and use of sleep suppressant. Information regarding challenges with attention deficit, memory loss, hyperemotional behavior, moodiness was also gathered from the participants. The participants also provided information relating to the characteristic of their sleep pattern. The obtained Likert responses were then reduced to binary responses of yes and no for a score of 3-4 and 1-2 respectively. The participant equally rated their current academic performance in the scale of 1 to 4 as ‘fair’, ‘unsatisfactory’, ‘good’ and ‘very good’ respectively (Table 1).

Handgrip test

A total of 57 volunteers, male (n=29) and females (n=28) participated in this experimental stage. The participants were divided into insomnia (n=27) and non-insomnia groups (n=30). Maximum voluntary contraction (MVC) was determined with an electronic hand dynamometer (Camry model EH101) as previously described in our study.[13] The participants were instructed to squeezed the dynamometer with their dominant hand, with maximum effort sustained for three to four seconds. This was determined twice and the average taken as the MVC. Thereafter, the subjects were instructed to compress the handle of the dynamometer at 30% of MVC for two minutes with a sphygmomanometer cuff (Omron model) positioned on the contralateral arm. Systolic and diastolic blood pressure plus heart rates were then taken at the end of the two minutes handgrip exercise, with the grip still sustained. Mean arterial pressure (MAP) was subsequently determined from systolic blood pressure (SBP) and diastolic blood pressure (DBP).

Data analysis

Categorical data were presented as frequencies and percentages, while continuous variables were presented as means and standard error of mean. Data file was converted into comma separated file, which was uploaded into Kaggle for descriptive analysis and data visualization and excel. Chi-square was used to test the association between categorical variables by finding the p values among proportions of variable between groups using GraphPad 5 software package. The significance level was set at 0.05.

Ethical consideration

The procedure for this study was approved by the health research ethic committee of the College of Medicine of the University of Lagos (CMUL/HREC/03/23/1155), and informed consent obtained from the participants.

RESULTS

Demography of the study participants

A total of 514 students, who were resident in the university hostels participated in the study, with 234 (45%) males, and 350 (55%) females respectively. 217 (42%) of the participants were from the faculty of clinical science, 177 (34%) from basic medical sciences and the remaining 120 (24%) from pharmaceutical sciences. The majority of the participant in the study, 208 (41%) and 187 (36%) were in their 4th and 3th academic years respectively, with the remaining 87 (17%) and 32 (6%) from 5th and 2nd academic year respectively. Most of the participants were between 20-25 years (88%), while the rest were between 16-19 years (8%) and 26-30years (4%) respectively (Table 1).

Table 1: Age, sex, faculty distributions and academic performances of study participants.

Variables	Insomnia present (%) ISI<15	Insomnia absent (%) ISI≥15	Total n=514	χ^2	P value
Age (years)					
16-19	16 (13)	27 (7)			
20-25	104 (83)	349 (90)	0.11		
26-30	5 (4)	13 (3)			
Sex					
Male	57 (25)	176 (75)	233 (45)	0.00	0.47
Female	68 (24)	213 (76)	281 (55)		
Faculty					
Clinical science	43 (20)	174 (80)	217 (42)	5.28	0.072
Medical science	45 (25)	132 (75)	177 (34)		
Pharmaceutical sciences	37 (31)	83 (69)	120 (24)		
Academic performance					
Very good	19 (15)	100 (26)	119 (23)	12.31	0.0064**
Good	70 (56)	223 (57)	293 (57)		
Fair	32 (25)	54 (14)	86 (17)		
Unsatisfactory	4 (4)	12 (3)	16 (3)		

Prevalence of insomnia among medical students

Using a cut-off mark ≥15 of a total of 28, a total number of 125 (25%) students had clinical insomnia, with 57 (45.6%) and 68 (54.6%) of these being males and females respectively.[12,14] Faculty of basic medical sciences, clinical science and faculty of pharmaceutical sciences accounted for 36% (45 students), 34% (43 students) and 30% (37) of the insomnia respectively, with the proportion of insomnia and non-insomnia at 20 versus 80% in medical science students, 25 versus 75%, in clinical science students and 36% versus 64% in students of pharmaceutical science, showing no association between insomnia and the students faculties (p=0.072) (Table 1).

Relationship between sleep duration, sleep time and insomnia scores

While, about 70% of the student participants had sleep duration ≤6 hours, just about 30% of them sleep for ≥7 hours (Figure 1A). Furthermore, a staggering majority of these students, about two-third (64%), responded to going to bed between 12 midnight and beyond 1 am, with just about one-third of them (36%) sleeping between 8-11 pm (Figure 1B). Furthermore, insomnia scores were higher with shorter sleep length (in hours) (Figure 2A) in both male and females, with just a few exceptions.

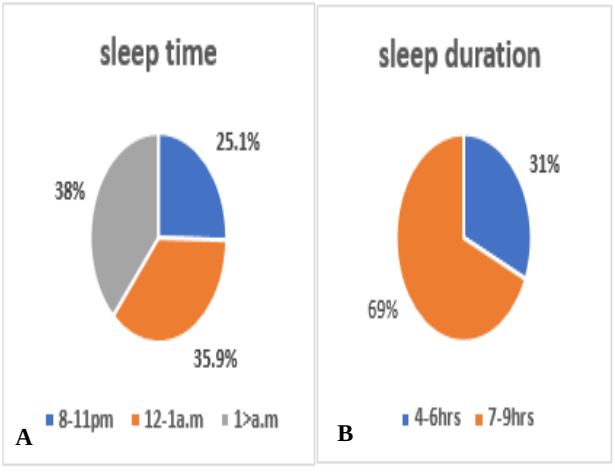

Figure 1: (A) Sleep duration; (B) sleep time.
The first pie chart shows the proportion of hours spent in sleep by the students, with just about a third of the participants (31%) sleeping for ≥7 hours versus 69% participants sleeping for ≤6 hours. The second pie chart shows that sleep time for about 64% participants was between 12 midnight and beyond compared to just about 36% that sleep between 8-11 pm.

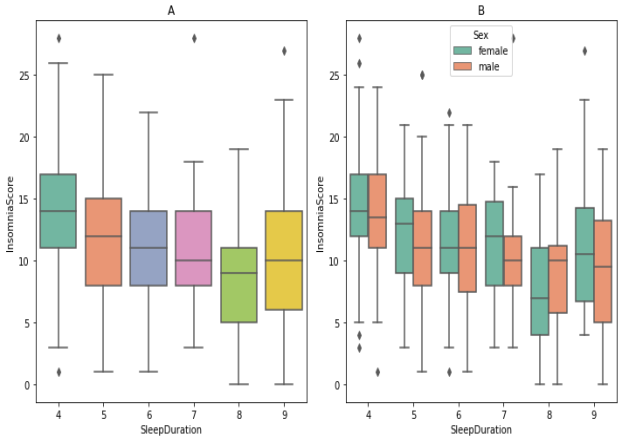

Figure 2: Boxplot showing distribution of insomnia scores on the basis of sleep duration and gender.

Clearly, upper quantile and median insomnia scores were higher with shorter sleep length (in hours); (A) in both male and females, with just a few exceptions.

Relationship between academic performance and insomnia

The self-reported academic performance of majority of students in this study included 'good' rating, by 293 (57%) students, which was immediately followed by a 'very good' rating, with 119 (23%) students. Similarly, a total of 100 (20%) students, 1 in every 5 students, combinedly reported a fair' and 'unsatisfactory' grades respectively. In terms of proportionality, fewer students with insomnia (15% versus 26%) rated their performance as 'very good', in contrast to the relatively higher proportion (25% versus 14%) that rated their performance as 'fair'. Meanwhile, 'good' (55 versus 57%) and 'unsatisfactory' rating (4% versus 3%) were fairly similar in both the insomnia and non-insomnia groups respectively, and an association was demonstrated to exist between poor sleep and academic performance among the participants (p=0.006) (Table 1).

Plausible predictors of occurrence of insomnia among medical students

Insomnia among students in this current study was significantly associated with academic stress (p<0.05, OR: 1.82), excessive use of digital activities (p<0.0001, OR: 3.59), environmental discomfort (p<0.001, OR: 2.73), emotional-related challenges (p<0.0001, OR: 3.95), health-related issues (p<0.0001, OR:3.73) and use of sleep suppressants (p<0.001, OR:2.77) (Table 2 and Figure 3).

Probable outcomes of insomnia among medical students

Clinical insomnia was also associated with attention deficit (46% versus 13%, p<0.001, OR: 6.69), memory loss (40% versus 15%, p<0.001, OR: 4.52), hyperemotional behaviour (41% versus 17%, OR: 3.31), mood change (64% versus 23%, p<0.0001, OR: 6.08). Again, there is high odd for attention deficit (OR: 6.67), memory loss (OR:4.52) and hyperemotional behaviour (OR: 3.31) in those with insomnia as revealed by our study (Table 2 and Figure 4).

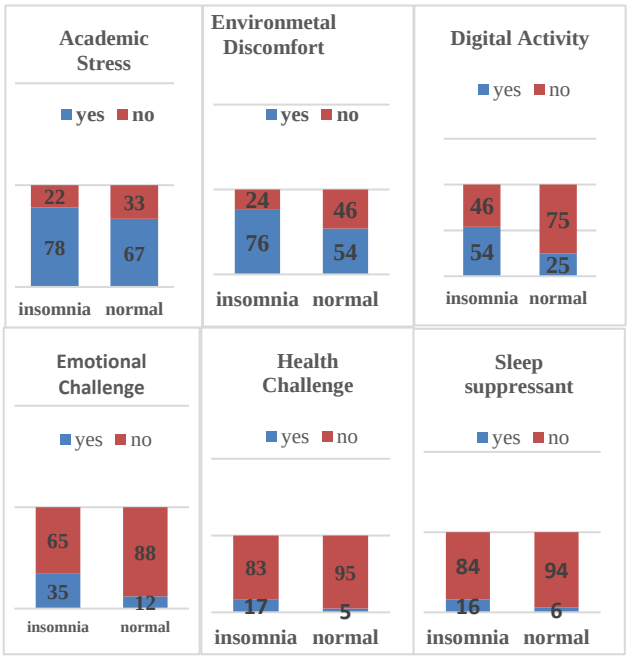

Figure 3: Bar chart showing the potential predictors of insomnia among medical undergraduate students of University of Lagos.

The predictors include presence or absence of academic stress, environmental discomfort, digital (android phone) activities, emotional challenge, health challenge and the use of sleep suppressant substance in insomnia versus non-insomnia (normal) students.

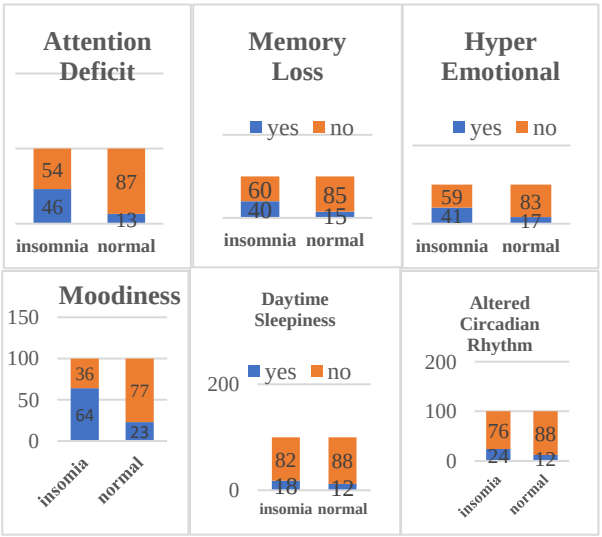

Figure 4: Bar chart showing the covariates of insomnia among medical undergraduate students of University of Lagos.

These include presence or absence of mood change, attention deficit, memory loss and hyperemotional traits in insomnia versus non-insomnia (normal) students.

Sleep pattern associated with insomnia among medical students

Students with insomnia often reported recalling their dream (40% versus 25%, p<0.001, OR: 2.21), sleeping better during the day (24% versus 12%, p<0.001; OR: 2.41), but less likely had nightmares (7% versus 5%, p=0.45. OR: 1.36) (Table 2).

Table 2: Variables associated with insomnia.

Variables	Insomnia (%)	Normal (%)	Odd ratio (OR)	χ^2	CI	P value
Academic stress						
Yes	98 (78)	259 (67)	1.82	6.23	1.13-2.93	0.013*
No	27 (22)	130 (33)				
Environmental discomfort						
Yes	95 (76)	209 (54)	2.73	19.42	1.73-4.31	<0.001***
No	30 (24)	180 (46)				
Health challenge						
Yes	21 (17)	20 (5)	3.73	17.5	1.65-3.29	<0.0001***
No	104 (83)	369 (95)				
Digital activity						
Yes	68 (54)	97 (25)	3.59	37.68	2.56-5.47	<0.0001***
No	57 (46)	292 (75)				
Emotional challenge						
Yes	44 (35)	47 (12)	3.95	34.7	2.45-6.37	<0.0001**
No	81 (65)	342 (88)				
Sleep suppressant use						
Yes	20 (16)	25 (6)	2.77	10.85	1.48-5.19	0.001***
No	105 (84)	364 (94)				
Attention deficit						
Yes	57 (46%)	50 (13)	5.68	61.64	3.59-9.01	<0.0001***
No	68 (54%)	339 (87)				
Memory loss						
Yes	50 (40)	58 (15)	3.81	35.88	2.42-5.99	<0.0001***
No	75 (60)	331 (85)				
Moodiness						
Yes	80 (64)	88 (23)	6.08	73.62	3.93-9.40	<0.0001***
No	45 (36)	301 (77)				
Hyperemotional						
Yes	51 (41)	67 (17)	4.07	42.54	2.62-6.33	<0.0001***
No	74 (59)	322 (83)				
REM dreaming						
Yes	53 (42)	97 (25)	2.21	13.83	1.45-3.37	0.0002***
No	72 (58)	291 (75)				
Daytime sleepiness						
Yes	23 (18)	47 (12)	1.65	3.28	0.96-2.85	0.07
No	102 (82)	344 (88)				
Nightmare						
Yes	9 (7)	21 (5)	1.36	0.56	0.61-3.05	0.45
No	116 (93)	368 (95)				
Alter circadian rhythm						
Yes	23 (18)	42 (12)	3.08	19.89	1.85-5.14	<0.0001***
No	102 (82)	344 (88)				

Relationship between cardiovascular responses to handgrip test

Changes in cardiovascular parameters namely HR (4.62±0.9 versus 6.55±3.7, p=0.56), SBP (18.2±2.5 versus 18.2±2.5, p=0.84), DBP (13.4±2.3 versus 13.4±2.3, p=0.25), MAP (9.4±1.7 versus 7.2±0.9, p=0.15) responses to 30% MVC handgrip test were nearly similar with no significant differences (p>0.05) between those experiencing insomnia and those without insomnia (Table 3).

Table 3: Blood pressure and heart rate responses to handgrip test at 30% MVC for 2 minutes.

Parameter	Control (n=30)	Insomnia (n=27)	P values
BMI (kg/m^2)Δ	23.4±0.7	23.3±0.8	0.47
MVC	24.2±0.8	22.2±1.1	0.06
HR (bpm) Δ	6.12±1.5	4.11±0.93	0.24
SBP (mmHg) Δ	16.8±1.8.*	10.6±2.0	0.02
DBP (mmHg) Δ	17.6±2.83*	13.4±2.3	0.02
MAP (mmHg) Δ	5.2±1.2	2.5±1.6	0.083

Cardiovascular parameters SBP, and DBP responses to 30% MVC handgrip test was significantly lower ($p<0.05$) in those experiencing insomnia compared with control group.

DISCUSSION

Globally, insomnia is reported to be a leading form of sleep disorder in the general population, and its prevalence is considerably soaring among student circle.[1,4] Therefore, our current work examined the prevalence of insomnia in this vulnerable population, with focus on the medical students of the College of Medicine of the University of Lagos, while also interrogating the possible predictors, associations and likely academic impact of this neuropsychological condition.

Prevalence of insomnia among medical students

Unlike the previously reported low prevalence of poor sleep of 7.7%, 9.9% and 10.6% among university students in Germany, Lebanon and Nigeria respectively the observed prevalence of clinical insomnia is more than twice higher in this current study at 24%, which is nearly the same at 25% and 26% reported in India and Jordan respectively, but lower than the 40.7% in Athens.[5,8,15-18] This current finding and previous studies aligned with the empirical evidence suggesting that poor sleep quality is preponderant among medical students globally.[19] However, our result did not find any gender-related association with insomnia, consistent with other previous finding, but contrary to other work that demonstrated such association.[19,20]

Sleep duration, bedtime and insomnia

Majority of the student participants in this current study evidently demonstrated a bed time and a sleep duration consistent with insomnia, with over two-third of them (69%) sleeping less than the recommended 7 hours, and a large proportion of them sleeping at and beyond 12 midnight.

This is consistent with a study among final year medical students in University of Jos, Nigeria and that among medical students in Karachi University in Pakistan with over 70% of them reporting going to bed after midnight.[5,21] Again, this finding is perfectly in alignment with a report that most university students sleep less than the recommended sleeping hours of 7 to 9 hours per day.[22]

Insomnia and academic performance

Before now, some studies have shown empirically that insomnia affects academic performance, by reporting a positive nexus between sleep quality and academic scores.[23] Likewise, looking at the academic performance of the students in this current study, we observed that 23% and 57%, respondents had 'very good' and 'good' ratings respectively, while 17% and 5% of the respondents had 'fair' and 'unsatisfactory' rating respectively according to a self-assessment questionnaire tool. Judging by the lower scale of the academic performance rating (fair and unsatisfactory scores), 1 in every 5 of the students (22%) rated themselves below the upper performance scale. Most importantly, a larger proportion of those with insomnia (25% versus 14%) fell within the 'fair performance rating'. In sharp, contrast, a fewer proportion of the students with insomnia (15% versus 26%) were within the very good performance ranking. Meanwhile, the proportion of students with 'good' rating were fairly the same for students with insomnia and those without insomnia (56% versus 57%).

In summary, there is a higher proportion of students with clinical insomnia occupying the bottom of the academic performance rating. Our result reinforces the rhetorics that poor sleep quality/sleep disturbance is related to unimpressive academic grade.[8,24] In addition, individuals with penchant for late night sleep and those with irregular sleep-wake scheduled have been shown to exhibit poorer academic performance with low GPA.[25] Not surprising, students that performed exceptionally in their academic work have been shown to go earlier to bed with higher sleep duration during weekdays.[26] However, in contrast to our results and other previous findings, some recent studies have also argued that shorter sleepers and poor sleepers have higher academic performance than sufficient sleepers.[27]

Predictors of clinical insomnia

Environmental discomfort, digital activities and health challenges were significantly associated with clinical insomnia among the students investigated in this current study, ditto for emotional challenges, consumptions of sleep suppressant drinks and academic stress. This observation is in tandem with previous study which revealed that poor sleep quality is related to unconducive

academic environment, characterized by excessive academic workload and unpleasant residential conditions.[28,29] Again, our work showed that more than half of the students with insomnia responded that digital activities contributed to their sleep disturbance in line with previous study that averred that spending long time with digital devices potentially impedes on sound sleep, especially among those who indulge in smartphones-related activities like video gaming and social networking few hours prior to sleep time.[30]

Most importantly, over exposure to the blue light from these devices prior to sleep time has been linked with delay in sleep initiation and shortens sleep time, while suppressing the release of melatonin, a sleep-inducing hormone.[31,32] Similarly, our observation aligned with previous findings that depressive mood and anxiety are plausible predictors of insomnia among students.[15,32] Meanwhile, although the use of sleep suppressant like coffee drinks, caffeine and energy drinks was uncommon in our present study, the proportion is nonetheless higher among those with insomnia compared to those without insomnia (16% versus 6%), and expectedly the use of sleep suppressants was positively associated with insomnia. Our finding is supported by several previous studies which demonstrated that taking caffeinated drink at night could negatively hamper sleep initiation, shorten sleep time, and disrupt sleep sustenance.[34,35]

Potential outcomes of clinical insomnia

Nearly two-fifth (40%) of the students with clinical insomnia in this current study reported attention deficit, memory loss and emotional instability which were significantly related to insomnia. In line with our findings, earlier studies suggest that insufficient sleep suppress alertness, attention, cognitive ability and positive mood.[15,36]

One plausible way through which sleep deprivation causes memory deficits is via the weakening of neuronal connectivity in hippocampal area CA1 and the attenuation of molecular processes involved with memory formation.[37,38] Again, our present work showed that mood change and emotional disturbance were significantly associated with insomnia. Meanwhile, only 13.6% of the students in this current study responded to having daytime sleepiness as against a much higher prevalence of around 30.5% reported among Brazilian and Indian medical students.[26,39] Surprisingly, there was no significant association between daytime sleepiness and insomnia in this our study. Nonetheless, excessive daytime sleepiness has been suggested to visibly impact on attention and alertness and this has been invariably shown to be associated with poor academic performance.[40]

Pattern of sleep

The prevalence of nightmare at 6% in this current study is comparable to the prevalence of 3% and 4.7% in India and China respectively.[17,41] Meanwhile, Schlarb et al in their study suggested that nightmare predicted insomnia very well contrary to the observation in our current study.[42] This is important as dream recalling has been previously reported to be the hallmark of REM sleep.[43]

Influence of sleep disturbance on cardiovascular responses to handgrip test

Handgrip test is a non-invasive test use to challenge cardiovascular system via the activation of sympathetic nervous system, with excessive response reflecting in abrupt rise in blood pressure and heart rate. Generally, it is unclear how heart rate responds to sleep deprivation. While some studies suggest that poor sleep is characterized by a rise in heart rate others suggest a fall, with some works also demonstrating no effect.[10,11,44] Meanwhile, our current result shows no significant differences in heart rate responses to handgrip test among insomnia and control groups. However, blood pressure response to handgrip test was significantly higher in the non-insomnia group in comparison to the insomnia group. Although this was unexpected, given the previously reported association of poor sleep with cardiovascular risk put at 45%.[45] Perhaps, the young ages brackets of our study population potentially compensated for this anticipated cardiovascular risk and hyperadrenergic response. It is not also impossible that the relatively higher muscular voluntary contraction in the control group accounted for this paradoxical disparity, thus drawing attention to possible muscular fatigues in the insomnia group.

This study has some limitations also. Although CGPA is the widely use tool for the objective evaluation of academic performance in related studies. This was however not feasible in this current study, given the non-GPA system for some faculties included in our study. Again, the convenient sampling adopted in this curret study allowed for the easy coverage of population of interest, nonetheless it is prone to bias. Also, a causal relationship between insomnia and academic performance could not be established owing to the cross sectional nature of the study design.

CONCLUSION

Based on our results, the prevalence of insomnia is high among medical students, at 24%, and could be predicted by presence of environmental discomfort, overindulgence in digital activities, academic workload and health challenges. The five top cognitive hallmarks of this biological experience include mood changes, attention deficits, memory loss, hyperemotional behavior, poor academic outing, with no corresponding cardiac hyperresponsiveness to handgrip test. This implied that

the observed insomnia among this young undergraduate may not carry corresponding cardiovascular risk as anticipated, judging by their attenuated cardiovascular response to handgrip test. It is however, recommended that further study be conducted with other techniques to evaluate the potential cardiovascular risk among younger individuals experiencing insomnia over a longer period. It is also recommended that measures be put in place to identify students with insomnia and mitigate the potential impact on their mental health and cognitive agility in our higher institution of learning.

ACKNOWLEDGEMENTS

The authors sincerely appreciate all the volunteers that participated in this study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee of the College of Medicine of the University of Lagos (CMUL/HREC/03/23/1155)

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Cite this article as: Agbaraolorunpo FM, Ogunyemi A, Ogunlunsi K, Jimoh W. Cognitive hallmarks of insomnia and its influence on cardiac response to handgrip test among medical students. Int J Community Med Public Health 2024;11:625-33.