



## Original Article

# Sleep disturbances and lack of exercises: accumulating factors for altered BMI in medical students of public sector universities

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## Abstract

**Background:** Changes in lifestyles such as lack of exercises and sleep can have negative effects on the body weight. Therefore, the present study was designed to investigate the association of the pattern of sleep, exercise, and diets with the body mass index (BMI) of medical students.

**Methodology:** This is a cross-sectional study that incorporates self-developed questionnaires. Participants are medical university students (250) living in Karachi, Pakistan. Correlation and Pearson's chi-square test for independence was applied to observe the association between BMI, sleep patterns, exercise and eating habits.

**Results:** The age of the students were between 19-25 years. The data show a significantly higher number of students (70.6%) with low BMI. Significantly high numbers of students have disturbed sleep (47.4%) during the nights and an increased number of students feel irritated (78.7%) about their sleeping pattern. Because of this, students (61.1%) experienced difficulties at work. Moreover, it was found that only 67 students are doing exercise while 154 students are not doing any exercises. However, they are taking enough 5-6 (47.1%) or 6-8 hours (29.9%) sleep. The majority of the students do not smoke (96.8%) or eat big meals before bed (62%) or consume junk foods (68.8%) on a daily basis. Nevertheless, most of them felt tired (61.1%) but not sleepy (57%) before going to bed. The majority of the students (81.4%) have problems waking up in the morning.

**Conclusion:** A Significant correlation was found between BMI and sleep duration. Irregular sleeping pattern and lack of physical activities are accumulating factors for students to be underweight. Sleep disturbances affected their focus on the academic studies. Therefore, it is strongly recommended for students to participate in physical activities.

## Keywords

Sleep disturbances, BMI, Exercises, Medical students.



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## Introduction

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Obesity is defined as a condition in which a person has accumulated an increased amount of fat that it might have a negative effect on their health. Obesity comorbidities include coronary heart disease, hypertension and stroke, dyslipidemia, non-insulin-dependent diabetes mellitus, sleep apnea<sup>1-4,6 7,8</sup>.

During the recent pandemic of obesity, Pakistan too has seen an increase in the population of overweight people, probably due to its increasing urbanization. This makes Karachi, one of the most urbanized regions of Pakistan, a high risk city<sup>9</sup>. The International Obesity Task Force has set the following cut-off points for adults in the Asia-Pacific region: overweight at BMI >23 and obesity at BMI >25. These lower cut-off points are set because studies show that Asian people are likely to develop comorbidities at lower BMI<sup>10</sup>. Students in different colleges regardless of the professions such as medical or basic sciences students experiencing a marked change in curriculum, peer pressure, social pressure, erratic schedule and stress/anxiety. Major shift in lifestyle habits most of the times such as unbalanced diets, alcohol intake, and lack of sleep can be very harmful for student's health<sup>11, 12, 13</sup>.

Sleep deprivation is another issue plaguing urbanized cities such as Karachi. Many longitudinal studies show a correlation between sleep loss and weight gain in adults. However, some other studies prove that sleep quantity does not have a significant effect on weight gain in adults but sleep quality does. It also allows to predict overall health of an individual such as depression, fatigue and complaints<sup>14</sup>. Gathered results showed insufficient poor quality of sleep is associated with sleep dissatisfaction in

young adults. Reported earlier an imbalance between calorie intake and physical activities are the precipitating factors involving obesity<sup>15,16</sup>. However numerous other factors are also known to be involved in the contribution of BMI-related obesity such as sleep<sup>17,18</sup>. Besides obesity an increasing number of young adults have been shown to be associated to their body-image. This body-image dissatisfaction induces an increased weight loss behavior among young females<sup>19</sup>. Using of non-scientific physical activity and poor diets were identified in underweight people. Apart from this several dietary regimes such as lack of water intake resulted in increased confusion, stress, fatigue<sup>20,21,22</sup> and tension with decreased vigor both in men and women.

Due to the conflicting results in different regions, it is hard to predict if there would be such a correlation in each setting. The link between sleep pattern with BMI and diets had not been studied in Karachi before. Therefore, we carried out a cross sectional study to determine the effects of quality of sleep on general health of medical students in Karachi. We hypothesized to investigate the association of the pattern of sleep, exercise, and diets with the body mass index (BMI) of medical students.

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## Methodology

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### Participants

The current study used a sample of 467 college students, a randomly selected sample size at registered colleges located in Karachi, Pakistan. There were 204 males, and 263 were females (153 from the extended family system while 314 from the nuclear family system). Participants' age ranged from 16 to 24 years.



## Measures

### *Participants and Study Design*

It is a cross sectional study on medical students at a public sector university, from Year 1 to Year 5. The study was conducted on medical students of a public sector university during the period of 1st Feb to 31st July, 2019. A sample size of 250 was calculated by using open epi an online software (Confidence level=95 %). The sampling technique used was non probability convenience sampling. The mean age of the participants were 23.6 years.

The participants included in the study were students of all ethnic groups and both genders, studying in a medical college. Students with sleep disorders (narcolepsy, Insomnia, Snoring, sleep talking, Night terrors, Rapid eye movements behavior disorders, obstructive sleep apnea) and those taking medications to manage their weight were excluded from the study. Measures of memory or focus were made by the information recorded by the participants that their memory and focus on the study has changed since they have weight and sleep issues. Moreover, the information also included that they have difficulties in retaining the knowledge and felt agitated. These symptoms only occurred when their sleep pattern changes otherwise they did not have problems in focusing (thinking about other things besides studying). No one has attention deficit disorders.

### *Self-administered questionnaire*

Verbal consent was taken from all participants. The questionnaire consisted of 34 close-ended questions, out of which the first 5 asked for demographic figures (age, gender, year of study, weight and height). The next 16 questions were related to sleep and factors that could affect the quality and the quantity of sleep (frequency and amount of caffeine intake). The Next 10 questions were related to weight and factors that could

cause weight change, for instance exercise and dietary patterns. To ensure the participants were not hesitant to answer all questions honestly, we provided full anonymity - by not asking for their names, contact numbers, or any other personal details. We reduced interviewer bias by using questionnaires instead of verbal interviews.

### *Body Mass index (BMI)*

Body Mass Index (BMI) was calculated as described previously. Briefly weight of an individual in kilograms is divided by height measured in meters squared. BMI from 18.0 to 25 is considered normal weight, BMI <18.5 is considered underweight, BMI 25 to 28 is considered overweight.

Actual BMI= weight (kg) (measured weight) / Height<sup>2</sup> (m)

### *Statistics*

Data was analyzed by using SPSS version 16.0 software. Bivariate Correlations and Pearson's chi-square tests for independence were used. Value of P < 0.05 was considered significant.

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## Result

There were 73.3 % female and 26.7 % male students (Table 1). The data show that mostly students (156) are underweight and very few (7) are overweight. Nevertheless 58 students have normal BMI. Chi-square test for independence show that there was a significant association of BMI with the sleeping hrs (p<0.00005). The data show that significantly (p<0.0005) increased numbers (98 vs 58) of students are aware about the importance of sleep (Table 1). It has been observed that students with low BMI (47%) are taking 5-6 hours and 43% are taking 6 to 8 hours sleep. While students (50%) with normal BMI are also taking 5-6 hours and



34.5% are taking 6-8 hours sleep. In our study we have very few students (7) who were overweight. Nevertheless, the data show mostly they are sleeping either less than 5 hours or 6-8 hours (Table 2). Current study also showed significant association between BMI and disturbed sleeping pattern during the night. It showed an increased number of students (74 %) who were underweight have disturbed sleep. They either wake up once (47.4%), twice (27.6%), or more than twice (6.4%) during a night. Students with normal weight also shows disturbances in the sleep, 50% of students wake up once and 20 % wakeup twice (Table 3). Significantly ( $p<0.0005$ ) increased number of students are not doing any physical exercises (67 vs 154) and those who does (67), mostly spent their times in either cycling, walking or other aerobic activities (Table 1). The duration of physical activities was mostly (14.9%) less than 30 mins. However significantly less number (5.4%) of students go beyond 60 mins of exercise (Table 4). Significantly ( $p<0.0005$ ) higher number of students (59.3%) don't work or don't stay awake at night (73.3%).

We have also investigated the quality of sleep among different classes of students. The data show a significant ( $p<0.0005$ ) association between quality of sleep and students studying in different academic year. It was found that as students were

promoted to the next higher classes the sleeping in the evenings were reduced. However significant amount of students is taking enough sleep (59.3%) nevertheless students are irritated about their sleeping patterns (78.7%). Many students experiencing wakefulness at least once (35.3%) and twice (47%) during night sleep. However, 43% student did not have disturbed sleep. Students that are feeling irritated (Table 5) about their sleeping pattern did not feel sleepy (57%) before going to bed however remained tired (61.1%) all night. This has put a significant negative effect on their work (61.1%). This habit can be associated with the fact that significant ( $p<0.0005$ ) number of students (46.2%) were not hydrating themselves with enough water (Table 5). Apart from the sleeping habits, eating habits of all the students remained significantly ( $p<0.0005$ ) satisfactory. Increased number of students (171) indulged themselves by eating fruits and avoid smoking (214), big meals (190) and junk foods (152) before going to bed (Table 1, 5).

Nevertheless 40.7% of the students are not taking enough sleep and 69.7% students are not doing exercises. Majority of the students (70.6%) are underweight (low BMI). This has reflected on their lack of interests in the studies and work (Table 1, 6).

**Table 1: Demographic characteristics of medical students in Pakistan.**

Variables	(Means $\pm$ SD)
<b>Age</b>	
Male	23.6 $\pm$ 1.07
Female	23.6 $\pm$ 1.07
<b>Gender</b>	<b>n (%)</b>



Male	59 (26.7)
Female	162 (73.3)
<b>BMI</b>	
Normal weight	58 (26.2)
Under weight	156 (70.6)
Overweight	7 (3.2)
<b>Enough Sleep</b>	
Yes	131 (59.3)
No	90 (40.7)
<b>Knowledge about Sleep</b>	
Yes	98 (70.6)
No	58 (26.2)
<b>Smoking</b>	
Yes	7 (3.2)
No	214 (96.8)
<b>Physical Exercise</b>	
Yes	67 (30.3)
No	154 (69.68)

**Table 2: The association of BMI with different sleep hours of medical students in Pakistan.**

Variables Sleep hours	BMI (Frequency %)			$\chi^2$	p- Value
	underweight	Normal weight	overweight		
< 5 hours	29 (18.6)	6 (10.3)	3 (42.9)	2.7	0.0005
5-6 hours	74 (47.4)	29 (50)	1 (14.3)		
6-8 hours	43 (27.6)	20 (34.5)	3 (42.9)		
> 8 hours	10 (6.4)	3 (5.2)	0 (0.0)		

**Table 3: The association of BMI with irregular sleep pattern of medical students in Pakistan.**

Variables Sleep disturbances	BMI (Frequency %)			p-Value
	underweight	Normal weight	overweight	
None	29 (18.6)	6 (10.3)	3 (42.9)	0.0001
Once	74 (47.4)	29 (50)	1 (14.3)	
Twice	43 (27.6)	20 (34.5)	3 (42.9)	
> Twice	10 (6.4)	3 (5.2)	0 (0.0)	

**Table 4: The association of physical exercises with the duration of exercises.**

Variables	Duration of Exercise (Frequency %)			$\chi^2$	p-Value
	< 30 mins	30-60 mins	>60 mins		
Aerobics/Walking	33 (14.9)	22 (10)	12 (5.4)	8.72	0.0001

**Table 5: The association of influencing factors with the weight of the students**

Variables	Frequency (%)	df	$\chi^2$	p-value
<b>Sleep duration</b>				
<5 hrs	38 (17.2)	138	7.95	0.0001
5-6 hrs	104 (47.1)			
6-8 hrs	66 (29.9)			
>8 hrs	13 (13)			
<b>Water Intake</b>				
Regular Intake	119 (53.8)	46	2.58	0.0001
Not Regular Intake	102 (46.2)			
<b>Irritation with Sleep pattern</b>				
Irritated	174 (27.1)	46	3.53	0.0001
Not Irritated	47 (21.3)			
<b>Sleep Pattern Effects on work</b>				
Affected	135 (61.1)	46	2.60	0.0001
Not Affected	86 (38.9)			
<b>Dietary Regime</b>				
<b>Junk Foods</b>				
Yes	69 (31.2)	46	2.81	0.0001
No	152 (68.8)			
<b>Feel Tired before bed time</b>				
Yes	135 (61.1)	46	2.58	0.0001
No	86 (38.9)			
<b>Feel Sleepy before bed time</b>				
Yes	95 (43)	2.92	46	0.0001
No	126 (57)			
<b>Spend More time in bed</b>				
Yes	180 (81.4)	2.83	46	0.0001
No	41 (18.6)			
<b>Meal Before Bed</b>				
Yes	31 (14)	2.69	46	0.0001
No	190 (86)			

**Table 6: The association of influencing factors with the weight of the students.**

		Sleep Hours	affect work	Irritated	Weight	Height	Exercise	Exercise Duration
<b>Sleep Hours</b>	Pearson Correlation	1	.141**	-.052**	.083**	.075**	-.035**	.011
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.414
	N	12738	12738	12738	12738	12738	12445	5306
<b>affect work</b>	Pearson Correlation	.141**	1	.109**	-.026**	.155**	-.102**	.071**
	Sig. (2-tailed)	.000		.000	.003	.000	.000	.000
	N	12738	12794	12794	12794	12794	12501	5362
<b>Irritated</b>	Pearson Correlation	-.052**	.109**	1	.196**	.106**	-.081**	.114**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000
	N	12738	12794	12839	12839	12839	12546	5406
<b>Weight</b>	Pearson Correlation	.083**	-.026**	.196**	1	.427**	-.189**	.183**
	Sig. (2-tailed)	.000	.003	.000		.000	.000	.000
	N	12738	12794	12839	12839	12839	12546	5406
<b>Height</b>	Pearson Correlation	.075**	.155**	.106**	.427**	1	-.093**	.142**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000
	N	12738	12794	12839	12839	12839	12546	5406
<b>Exercise</b>	Pearson Correlation	-.035**	-.102**	-.081**	-.189**	-.093**	1	-.223**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000
	N	12445	12501	12546	12546	12546	12546	5296
<b>Duration of exercise</b>	Pearson Correlation	.011	.071**	.114**	.183**	.142**	-.223**	1
	Sig. (2-tailed)	.414	.000	.000	.000	.000	.000	
	N	5306	5362	5406	5406	5406	5296	5406

\*\* . Pearson Bivariate Correlation is significant at the 0.01 level (2-tailed).

## Discussion

Current study included medical students from different colleges with different ethnic backgrounds, socio-economic status, and different life style choices. The students did not have any sleeping disorders, diabetes, obesity or any genetic diseases the time we have conducted the study. However, this does not mean that a student cannot acquire these diseases in any time of the course. The curriculum is itself is a very long and strenuous, many students comes under

severe social pressure and stress that effects their sleep, body weight and mental health.

Previously studies have pointed out the correlation of sleep hours with an increase BMI. For example, according to Vergas and his colleagues (2014) sleep deprivation can induce an increase fat intake and predisposing to obesity. Other longitudinal studies over the years have also shown that reduced sleep is associated with weight gain contributing as a risk factor to obesity<sup>23</sup>.



In contrast to the previous studies, we showed 70 % of the students have low BMI, 26.2 % have normal BMI and 3.2% have high BMI. Moreover 69.7 % students do not exercise or have any physical activities while only 30.3% are involved in physical activities such as cycling or walking for 30-60 mins. Furthermore 40 % students do not sleep enough and 75 % students have disturbed sleep. Moreover 78.7% students are irritated about their sleeping pattern and 61% students remained tired. In addition to this 57 % students do not feel sleepy before going to bed and like (81.4%) to spend much time in the bed. These habits reflect poorly on the academic performances because majority of the students (61.1 %) have problems in learning and memorizing. The associations and correlations studies between BMI and all the categorical factors are significant in our study and this made all the authors to argue that either low BMI leading towards poor sleep pattern or poor sleep pattern leading towards lack of exercise or low BMI leading towards lack of exercise or lack of exercise leading towards the low BMI and poor sleeping pattern. All these scenarios can be true because these factors are interlinked with one another. Many studies have shown that students experienced sleep problems more often during their academic lives that put a negative impact on their well-being<sup>24-31</sup>. To analyze the quality of life one must observe sleeping pattern because it covers many clinical aspects such as depression, fatigue, and sleepiness. There is significant link between poor sleep, high calorie rich diets and lack of physical exercises with obesity<sup>11,16</sup>. Neurochemicals in humans for 7-8 hours consolidated sleep induces an inhibition towards glucose utilizations and glucose production in the first few hours and increases rapidly just before dawn<sup>32,33</sup> hours. Upon disturbed sleep the glucose utilization pathways are altered which means constant blood glucose levels remains all night

leading to the development of insulin resistance, cardiovascular diseases and obesity<sup>1,6,7,34,17,35,36</sup>. Disturbed sleep but not sleeping hours also changes the levels of hormones such as ghrelin (increase hunger) and leptin (inhibit hunger)<sup>37,38,1,2,3,5,8</sup> that decreases the insulin sensitivity, reduced glucose tolerance, diabetes<sup>39</sup> and appetite control. These factors also lead to the poor and unbalanced diet behaviors and lower the physical activity levels in young people<sup>40,41</sup>. The low BMI and disturbed sleep in the current study can be explained in that context. Recently, in China underweight people are considered to be beautiful, this stir image consciousness in female students. This puts lots of social pressure to achieve weight-loss goals by taking weight reducing products<sup>42</sup>. People having BMI <18.5 is considered as underweight and put them at risk for having health issues in longer term. There is reduced synthesis of sex hormones and bone mineral density, anemia, low blood pressure, fatigue, discomfort. They will have higher chances to develop eating disorders such as anorexia nervosa, bulimia nervosa and binge eating disorders<sup>43-47</sup> In addition to this underweight people might experience infertility and preterm birth<sup>48-51</sup>. Medical students often complain of stress due to burden of their heavy curriculum because of which they tend to skip meals during their day. Increased work load resulting in stress causes the body to consume more energy than is being consumed as food which can cause weight loss. Another possible reason can be due to the fact that the medical students become more health conscious to maintain a good physique because they are aware of how obesity can be a risk factor for many chronic and long term diseases like diabetes and cardiovascular comorbidities. Our findings suggest the importance of exercises or physical activities to improve the blood oxygen levels in the body which increased muscular strength, endurance, improve sleep, maintain weight, increased





energy levels, improve brain, heart and lungs functions.

### Limitations

A total of 250 students were approached with the questionnaire. Out of these, 16 students refused participation, while 13 students left the questionnaire incomplete and were excluded from the study. Accumulation of the data lasted for a period of six months among medical students in Karachi. Future studies should incorporate a larger sample size with students from the different disciplines.

### Conclusion

Irregular sleeping pattern and lack of physical activities are accumulating factors for students to be underweight. Sleep disturbances affected their focus on the academic studies. Therefore, it is strongly recommended for students to participate in physical activities.

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### References

- Nagai M, Tomata Y, Watanabe T, Kakizaki M, Tsuji I. Association between sleep duration, weight gain, and obesity for long period. *Sleep Med* 2013; 14: 206-10.
- Morselli L, Leproult R, Balbo M, Spiegel K. Role of sleep duration in the regulation of glucose metabolism and appetite. *Best Pract Res Clin Endocrinol Metab.* 2010; 24:687-702.
- Szinnai G, Schachinger H, Arnaud MJ, Linder L, Keller U (2005) Effect of water deprivation on cognitive-motor performance in healthy men and women. *Am J Physiol Regul Integr Comp Physiol* 289: R275-R280.
- Petri NM, Dropulic N, Kardum G (2006) Effects of voluntary fluid intake deprivation on mental and psychomotor performance. *Croat Med J* 47: 855- 861.
- Shirreffs SM, Merson SJ, Fraser SM, Archer DT (2004) The effects of fluid restriction on hydration status and subjective feelings in man. *Br J Nutr* 91: 951- 958.
- Ganio MS, Armstrong LE, Casa DJ, McDermott BP, Lee EC, et al. (2011) Mild dehydration impairs cognitive performance and mood of men. *Br J Nutr* 106: 1535-1543.
- Armstrong LE, Ganio MS, Casa DJ, Lee EC, McDermott BP, et al. (2012) Mild dehydration affects mood in healthy young women. *J Nutr* 142: 382-388.
- Pross N, Demazières A, Girard N, Barnouin R, Santoro F, Chevillotte E, Klein A, Le Bellego L. Influence of progressive fluid restriction on mood and physiological markers of dehydration in women. *Br J Nutr.* 2013 Jan 28;109(2):313-21. doi: 10.1017/S0007114512001080. Epub 2012 Apr
- Anstine D, Grinenko D. Rapid screening for disordered eating in college-aged females in the primary care setting. *J Adolesc Health.* 2000; 5:338-42. 13.
- Wardle J, Haase AM, Steptoe A. Body image and weight control in young adults: international comparisons in university students from 22 countries. *Int J Obes (Lond).* 2006; 30(4): 644-651.
- Yaemsiri S, Slining MM, Agarwal SK. Perceived weight status, overweight diagnosis, and weight control among US adults: the NHANES 2003-2008 Study. *Int J Obes.* 2011; 35:1063-70.
- Lei Zhang, Haihong Qian, Hua FuID. (2018). To be thin but not healthy - The body-image dilemma may affect health among female university students in China. *PLoS ONE* 13(10).
- Perla A. Vargas, Melissa Flores, and Elias Robles (2014). Sleep Quality and Body Mass Index in College Students: The Role of Sleep Disturbances. *J Am Coll Health.* 62(8): 534-541.
- Ruthig J, Haynes T, Stupnisky R, Perry R. Perceived Academic Control: mediating the effects of optimism and social support on college students' psychological health. *Soc Psychol Educ.* 2009; 12(2):233-49.



15. Nelson MC, Story M, Larson NI, Neumark-Sztainer D, Lytle LA. Emerging Adulthood and College-aged Youth: An Overlooked Age for Weight-related Behavior Change. *Obesity Res.* 2008; 16(10):2205-11.
16. Arnett, JJ. Emerging adulthood: Understanding the new way of coming of age. In: Arnett, Jeffrey Jensen; Tanner, Jennifer Lynn, editors. *Emerging adults in America: Coming of age in the 21st century.* Washington, DC: American Psychological Association; 2006. p. 3-19.
17. Hicks RA, Fernandez C, Pellegrini RJ. Striking changes in the sleep satisfaction of university students over the last two decades. *Percept Mot Skills.* 2001; 93(3):660.
18. Hill JO, Wyatt HR, Reed GW, Peters JC. Obesity and the Environment: Where Do We Go from Here? *Science.* 2003; 299(5608):853-5.
19. Veerman JL, Barendregt JJ, van Beeck EF, Seidell JC, Mackenbach JP. Stemming the Obesity Epidemic: A Tantalizing Prospect. *Obesity Res.* 2007; 15(9):2365-70.
20. Al-Disi D, Al-Daghri N, Khanam L, Al-Othman A, Al-Saif M, Sabico S, Chrousos G. Subjective sleep duration and quality influence diet composition and circulating adipocytokines and ghrelin levels in teen-age girls. *Endoc J.* 2010; 57(10):915-23
21. Shankar A, Syamala S, Kalidindi S. Insufficient rest or sleep and its relation to cardiovascular disease, diabetes and obesity in a national, multiethnic sample. *PLoS One.* 2010; 5(11):e14189.
22. Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. *PLoS Med.* 2004 Dec.1(3) .
23. Stamatakis KA, Punjabi NM. Effects of Sleep Fragmentation on Glucose Metabolism in Normal Subjects. *Chest.* 2010; 137(1):95-101.
24. Lesser DJ, Bhatia R, Tran WH, Oliveira F, Ortega R, Keens TG, Mittelman SD, Khoo MC, Davidson Ward SL. Sleep fragmentation and intermittent hypoxemia are associated with decreased insulin sensitivity in obese adolescent Latino males. *Pediatr Res.* 2012; 72(3):293-8.
25. Lucassen EA, Rother KI, Cizza G. Interacting epidemics? Sleep curtailment, insulin resistance, and obesity. *Ann N Y Acad Sci.* 2012; 1264(1):110-34.
26. Chaput JP, Brunet M, Tremblay A. Relationship between short sleeping hours and childhood overweight/obesity: results from the Quebec en Forme Project. *Int J Obes.* 2006; 30(7):1080-5.
27. Gangwisch JE, Malaspina D, Babiss LA, Opler MG, Posner K, Shen S, Turner JB, Zammit GK, Ginsberg HN. Short sleep duration as a risk factor for hypercholesterolemia: analyses of the National Longitudinal Study of Adolescent Health. *Sleep.* 2010; 33(7):956-61.
28. Tasali E, Leproult R, Ehrmann DA, Van Cauter E. Slow-wave sleep and the risk of type 2 diabetes in humans. *Proc Natl Acad Sci USA.* 2008; 105(3):1044-9.
29. Kong AP, Wing YK, Choi KC, Li AM, Ko GT, Ma RC, Tong PC, Ho CS, Chan MH, Ng MH, Lau J, Chan JC. Associations of sleep duration with obesity and serum lipid profile in children and adolescents. *Sleep Med.* 2011; 12(7):659-65.
30. Buxton OM, Cain SW, O'Connor SP, Porter JH, Duffy JF, Wang W, Czeisler CA, Shea SA. Adverse metabolic consequences in humans of prolonged sleep restriction combined with circadian disruption. *Sci Transl Med.* 2012; 4(129):129-43
31. Kobayashi D, Takahashi O, Deshpande GA, Shimbo T, Fukui T. Relation between metabolic syndrome and sleep duration in Japan: a large scale cross-sectional study. *Intern Med.* 2011; 50(2): 103-7.
32. Markwald RR, Melanson EL, Smith MR, Higgins J, Perreault L, Eckel RH, Wright KP. Impact of insufficient sleep on total daily energy expenditure, food intake, and weight gain. *Proc Natl Acad Sci.* 2013; 110(14):5695-5700.
33. Roenneberg T, Allebrandt KV, Meroz M, Vetter C. Social jetlag and obesity. *Curr Biol.* 2012; 22(10):939-43.
34. Morris CJ, Yang JN, Scheer FA. The impact of the circadian timing system on cardiovascular and metabolic function. *Prog Brain Res.* 2012; 199:337-58.
35. Seicean S, Kirchner HL, Gottlieb DJ, Punjabi NM, Resnick H, Sanders M, Redline S. SleepDisordered Breathing and Impaired Glucose Metabolism in Normal-Weight and



- Overweight/ Obese Individuals The Sleep Heart Health Study. *Diabetes Care*. 2008; 31(5):1001-1006.
36. Zhang L, Qian H, Fu H (2018) To be thin but not healthy - The body-image dilemma may affect health among female university students in China. *PLoS ONE* 13(10)
  37. Lund HG, Reider BD, Whiting AB, Prichard JR. Sleep Patterns and Predictors of Disturbed Sleep in a Large Population of College Students. *J Adolesc Health*. 2010; 46(2):124-32.
  38. Trockel MT, Barnes MD, Egget DL. Health-related variables and academic performance among first-year college students: Implications for sleep and other behaviors. *J Am Coll Health*. 2000; 49(3):125-31.
  39. Gaultney JF. The prevalence of sleep disorders in college students: impact on academic performance. *J Am Coll Health*. 2010; 59(2):91-7.
  40. Buboltz WC Jr, Brown F, Soper B. Sleep Habits and Patterns of College Students: A Preliminary Study. *J Am Coll Health*. 2001; 50(3):131.
  41. Sing CY, Wong WS. Prevalence of Insomnia and Its Psychosocial Correlates Among College Students in Hong Kong. *J Am Coll Health*. 2010; 59(3):174-82.
  42. Kenney SR, LaBrie JW, Hummer JF, Pham AT. Global sleep quality as a moderator of alcohol consumption and consequences in college students. *Addict Behav*. 2012; 37(4):507-12.
  43. Nyer M, Farabaugh A, Fehling K, Soskin D, Holt D, Papakostas GI, Pedrelli P, Fava M, Pisoni A, Vitolo O. Relationship Between Sleep Disturbance and Depression, Anxiety, and Functioning in College Students. *Depress Anxiety*. 2013; 00:1-8.
  44. Al-Disi D, Al-Daghri N, Khanam L, Al-Othman A, Al-Saif M, Sabico S, Chrousos G. Subjectivesleep duration and quality influence diet composition and circulating adipocytokines and ghrelin levels in teen-age girls. *Endoc J*. 2010; 57(10):915-23.
  45. Shankar A, Syamala S, Kalidindi S. Insufficient rest or sleep and its relation to cardiovascular disease, diabetes and obesity in a national, multiethnic sample. *PLoS One*. 2010; 5(11):e14189. [PubMed: 21152066]
  46. Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. *PLoS Med*. 2004 Dec.1(3):e62.
  47. Stamatakis KA, Punjabi NM. Effects of Sleep Fragmentation on Glucose Metabolism in Normal Subjects. *Chest*. 2010; 137(1):95-101.
  48. Lesser DJ, Bhatia R, Tran WH, Oliveira F, Ortega R, Keens TG, Mittelman SD, Khoo MC, Davidson Ward SL. Sleep fragmentation and intermittent hypoxemia are associated with decreased insulin sensitivity in obese adolescent Latino males. *Pediatr Res*. 2012; 72(3):293-8.
  49. Lucassen EA, Rother KI, Cizza G. Interacting epidemics? Sleep curtailment, insulin resistance, and obesity. *Ann N Y Acad Sci*. 2012; 1264(1):110-34.
  50. Chaput JP, Brunet M, Tremblay A. Relationship between short sleeping hours and childhood overweight/obesity: results from the Quebec en Forme Project. *Int J Obes*. 2006; 30(7):1080-5.
  51. Gangwisch JE, Malaspina D, Babiss LA, Opler MG, Posner K, Shen S, Turner JB, Zammit GK, Ginsberg HN. Short sleep duration as a risk factor for hypercholesterolemia: analyses of the National Longitudinal Study of Adolescent Health. *Sleep*. 2010; 33(7):956-61.

