DAILY AND SEASONAL SLEEP PATTERNS IN SCHOOL STUDENTS

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DAILY AND SEASONAL SLEEP PATTERNS IN SCHOOL STUDENTS

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Submitted

In partial fulfillment of the requirement of the Degree of Doctor of Philosophy in Zoology of Mizoram University, Aizawl.

CERTIFICATE

I certify that the thesis entitled "**Daily and Seasonal Sleep Patterns in School Students**" submitted to the Mizoram University for the award of the degree of Doctor of Philosophy in Zoology by **J. Lalremruati** is a record of research work carried out during the period of 2018 - 2023 under my guidance and supervision, and that this work has not formed the basis for the award of any degree, diploma, associateship, fellowship or other titles in this University or any other University or institution of higher learning.

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DECLARATION
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I **J. Lalremruati**, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to do the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/Institute.

This is being submitted to the Mizoram University for the degree of **Doctor of Philosophy** in Zoology.

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(J. LALREMRUATI)

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GENERAL INTRODUCTION

Biological rhythms are the cyclical differences in physiological and behavioral activity. The biological rhythm involve sleep/wake patterns, societal action, eating habits, and other significant physical purposes. The circadian clock-controlled these rhythms by an endogenous mechanism. Almost all organisms have an endogenous rhythm pattern that circulates daily to accommodate the 24-hour light-dark cycle (Orozco-Solis and Sassone-Corsi, 2014). Biological rhythms with a frequency of about 24 hours are called circadian rhythms. According to the two-process model, the timing and consolidation of sleep are regulated by a circadian and a homeostatic process (Borbély, 1982; Daan et al., 1984). In the daily cycle, the sleep pressure is driven by homeostatic forms during awakening while degenerates during sleep. In humans and other diurnal animals, the circadian clock endorses awakening in the daytime and sleeping during night-time. The sleep pressure builds up as it increases the chances of sleeping, and then the circadian clock ends stimulating sleeplessness but begins stimulating sleep. The different characteristics of sleep properties predicted by the two-process sleep model are remarkable for society and behavior. For example, the duration of sleep is short once the presence of sleeping happens outside the circadian frame, predetermining the shift worker's schedule or individual who needs an alarm clock and then correlating on the way to chronic sleep insufficiency. Almost all functions of physical and mental differences in the rhythm were observed on various levels, from the single cells to social activities.

The human behavioral and humoral rhythms are driven by the suprachiasmatic nucleus (SCN), the central circadian clock, which is situated in the hypothalamus. However, this circadian oscillation is identified in the cells of the central nervous system as well as several other cells. The SCN regulates daily sleep/wake cycles and diurnal changes in physiological processes such as body temperature and hormone secretion such as melatonin (Weaver, 1998; Roenneberg et al., 2007). Environmental cues known as “Zeitgebers” can entrust these daily physiological processes. The daily light-dark cycle is the most reliable environmental zeitgeber. The hormone melatonin, primarily secreted from the pineal gland, is essential to the body's time-keeping system. It regulates physiological processes, including the sleep/wake cycle (Pandi-Perumal et al., 2008; Waterhouse, 2009).

In humans, daily changes in body temperature, secretion of many hormones, fluctuations of many organ systems, immune system, sleep, and wakefulness are the few physiological processes under circadian clock regulation and examples of circadian rhythms. Corresponding to these physiological activities, several psychological processes and mental functions that affect human performance exhibit circadian oscillation. The association between rhythm and certain diseases has led to the notion that rhythmic bodily function is a characteristic of good health and that circadian disruption harms health (Roveda et al., 2018; Roveda et al., 2019; Galasso et al., 2019). Daily light-dark cycles are the most dominant entraining or synchronizing agents in most species, including humans. However, human sleep/wake schedules and social cues may also synchronize circadian rhythms. During the circadian rhythms resetting, the length and progression of variations within it may not alter, but the beginning and end of the cycle are adjusted. The flexibility of a circadian rhythm in modifying to different environmental cues determines the degree to which the timing of the function controlled by that rhythm can be altered. Individuals entrain differently depending on exogenous (i.e., light exposure) and endogenous (i.e., circadian response characteristics) factors that produce different phenotypes, known as chronotypes (Roenneberg, 2015). Individuals vary in their preferred timing of day-to-day activity patterns, like the timing of bed and wake-up time. This morning/evening preference is a continuum but is usually divided into three chronotypes: morning type, evening type, and neither type (Horne and Ostberg, 1976; Kerkhof, 1985). Chronotype is undoubtedly linked with nocturnal sleep quality. Individuals characterized by more extreme positions towards morningness or who do their best mentally or physical in the morning hours are referred to as 'early larks' or morning type. Alternatively, individuals more extreme toward eveningness or do best in the evening or at night are known as 'night owls' or evening type. Individuals between the morning type and evening type are called neither type. Various studies indicate that the morningness-eveningness preference of children shifts from morning type to evening type in the early puberty stage (Randler et al., 2014; Kim et al., 2002; Roenneberg et al., 2004).

In addition, in this era, factors such as lighting technologies, information, communication technologies, and lifestyle seem to affect individuals' sleep/wake schedules and overall sleep length, thus increasing the number of evening type individuals (Vollmer et al., 2012). Additionally, individuals mainly spent their holidays or weekends for sleeping in order to compensate for their workdays or weekdays sleep insufficiency. The misalignment between biological and social time caused by school or work is called social jetlag (Roenneberg et al., 2012). Numerous studies indicate that social jetlag and sleeplessness negatively correlate with school success (Drake et al., 2003, Kelly et al., 2001; Lee et al., 1999; Medeiros et al., 2001; Wolfson and Carskadon, 1998). Several issues affect sleep quality and other parameters of sleep, like the person's biological features, mental health condition, social environment, living standards, and technological devices they use.

Variations in intrinsic circadian rhythms cause variations in chronotype (Duffy et al., 2001; Lack et al., 2009). Chronobiological and chronopsychological research studies have documented that some critical individual differences (Tankova et al., 1994) are associated with morningness-eveningness, such as age (Paine et al., 2006), sex (Muro et al., 2009; Paine et al., 2006), working schedule (Pearson, 2004; Randler, 2008), or personality (Adan et al., 2010a, 2010b; Digdon and Howell, 2008; Muro et al., 2009; Tonetti et al., 2009). Research has revealed that eveningness is related to higher neuroticism (Tonetti et al., 2009), lower self-control and self-regulation, as well as greater procrastination (Digdon and Howell, 2008), higher novelty seeking, and lower harm avoidance (Adan et al., 2010a). On the other hand, morningness is linked with higher conscientiousness (Tonetti et al., 2009), as well as general and work activity (Muro et al., 2009). The relationship between daytime preferences and numerous characters is a documented system of morningness-eveningness. Adolescents with eveningness are more likely to have poorer sleep quality and sleep less on weekdays than those with morningness (Giannotti et al., 2002; Warner et al., 2008). Adults of the morning type had higher sleep efficiency than those of the evening type (Lehnkering and Siegmund, 2007). Compared with participants of the morning and neither type, those of the evening type have reported more time in bed and more significant variability in time out of bed (Taillard et al., 1999; Ong et al., 2007). Therefore, night-time sleep pattern has been proved by the link between morningness-eveningness preference and the quantity and quality of sleep. Although the frequency differs, some adolescents and young people were informed to have insufficient and delayed sleep schedules. Furthermore, a remarkable degree of problems associated with sleeping and poor sleep quality have been observed in university students of many Western countries (Brown et al., 2002; Buboltz et al., 2001; Hicks et al., 1999; Lack, 1986; Manni et al., 1997).

Adolescent sleep problems may be mediated by cultural and local factors, which is essential to study given the emerging understanding of circadian clock-related impacts on adolescent sleep characteristics. Most research on adolescents' sleep habits, daytime tiredness, and levels of depression has been done in developed countries. However, adolescents' sleeping patterns and behavior in developing countries have yet to be understood. Some scattered study reflects sleep challenges among the Indian population (Murugesan et al., 2018; Yadav and Singh, 2014). However, most of these studies have been conducted in metro cities situated at low altitudes but not in those living at higher altitudes.

Further, previous studies have also been conducted in schools having inconsistent school timings. Therefore, the study was conducted among different school students within Aizawl City, the capital of Mizoram. Aizawl is located north of the Tropic of Cancer in the northern part of Mizoram. It is a hilly city on a ridge of 1,132 meters above sea level. There is an incredible impact of local environmental conditions on the life habits of the Mizo population, and late-night recreational activities are minimal. Furthermore, it is one of the few cities where school times (9:00 AM to 3:30 PM) are identical for all high and higher secondary schools. Therefore, it provides the opportunity to understand the chronotype and gender-based differences in sleep parameters and seasonal sleep variations in adolescents inhabiting higher altitudes and attending schools with identical school timings.

The present thesis

The thesis includes the study of sleep duration and sleep quality, gender differences, the persistence of social jetlag, and seasonal sleep variations in school students. The study was performed among school-going students of both sexes of 14-20 years of age group (16.9±0.1). The study included 900 students; out of the total subjects, 409 participants were male, and 491 were female. Subjects were asked to answer a different questionnaire to assess their sleep duration, sleep quality, daytime sleepiness, sleep habits during the previous month, and self-rating depression levels and access their sleep/wake patterns via armband actigraphy. The sleep/wake patterns were collected from 456 school students, 216 male and 240 female participants; actigraphy reports were used in this study. The different sleep measures were calculated: bed-time and get-up time, time in bed (TIB), total sleep time (TST), sleep onset latency (SOL), sleep efficiency (SE), wake after sleep onset (WASO), and mid-sleep time. Different objectives conducted in the study are summarized in the following sections.

Section 1.To study sleep duration and sleep quality

This section examines the duration and quality of sleep among school students.

Section 2.To study gender differences in sleep habits, sleep quality, and daytime sleepiness

This section covers the study of gender differences among school students in their sleep habits, sleep quality, and daytime sleepiness.

Section 3.To study the persistence of social jetlag

Here we studied weekdays and weekends sleep/wake patterns among school students.

Section 4.To study seasonal sleep variations

In this section, we studied seasonal sleep/wake patterns, and the study was performed four times a year.

Section 5. Changes associate with chronotype, sleep pattern, and depression levels among school students during the pandemic Covid-19 lockdown and post-lockdown online classes

This experiment examined sleep patterns and depression levels during the Covid-19 pandemic among school students.

Section 6. Chronotype-dependent academic performances among school and university students

In this study, we compared the grade points based on chronotype and gender-wise among school and university students.

Section 7. Study of food addiction, chronotype, depression level, and sleep quality among school, university students, and working adults

This section studied food addiction, chronotype, depression level, and sleep quality among school, university students, and working adults. Here, the correlation was analyzed between food addictions and the other parameters.

GENERAL MATERIALS AND METHODS

Study design and participants

The study was conducted among school students within Aizawl, Mizoram. The school-going students of high school and higher secondary classes were selected. The students were approached individually via school administration, and the study had no selection bias. To collect information for this study, a different self-administered assessment was used, including age, sex, class, address, and school timing. Before beginning the study, the study's aim, objectives, and purpose were informed to all the participants. The consent was obtained individually from the volunteers, and the participants could withdraw their participation from the study at any time. Individual confidentiality was maintained throughout the study. The study was conducted as per the guidelines of the Institutional Human Ethics Committee of Mizoram University (No. MZU/IHEC/ 2019/001).

Demographic data of school students

Characteristics	Category	N (%)	Mean ±SEM
Gender	Male	409 (45.4%)	
	Female	491 (54.5%)	
Age (years)	14-20		17.2±0.1
	14-19		16.8±0.1
Height			5.6±0.0
			5.1±0.0
Weight			56.7±0.4
			51.1±0.3
Class	9	210 (23.3%)	
	10	242 (26.8%)	
	11	215 (23.8%)	
	12	233 (25.8%)	

Procedures for data collection

The volunteers were asked to answer different questionnaires. All the questionnaires were randomly distributed to the students and collected during school hours. Daytime sleepiness was measured by using Pediatric Daytime Sleepiness Scale (PDSS), and Epworth Sleepiness Scale (ESS). Pittsburgh's Sleep Quality Index (PSQI) was used for the assessment of sleep habits during the previous month, such as bed-time, get-up time, sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The sleep pattern was assessed by Cleveland Adolescent Sleepiness Questionnaire (CASQ). Morningness-Eveningness Questionnaire (MEQ) was used for the measurement of chronotype. The depression level was evaluated using Zung Self-Rating Depression Scale (SDS). Incomplete and poor responses were excluded from the analysis. The sleep/wake patterns were also recorded using armband actigraphy.

a. Pediatric Daytime Sleepiness Scale (PDSS): Pediatric Daytime Sleepiness Scale (PDSS) was created by Drake et al., (2003). PDSS questionnaire is a self-reported questionnaire for the assessment of the link between daytime sleepiness and school-related consequences and consists of 8 questions for sleep-related behavior. A Likert-scale format (e.g., never, seldom, sometimes, frequently, always) was used in all the questions. Based on the Likert-scale assessments, the scores range from 0 to 4 (never = 0; seldom = 1; sometimes = 2; frequently = 3; always = 4). Responses to question number 3 (Are you alert most of the day?) were reverse scored (i.e., always = 0; frequently = 1; sometimes = 2; seldom = 3; never = 4) to lessen the chance of response bias. The total scores range from 0 - 32; higher scores of PDSS were related to short sleep duration, poor academic achievement, and regular sickness.

Pediatric Daytime Sleepiness Scale (PDSS)

Sl. No.	Questions	Always	Frequently	Sometimes	Seldom	Never

1	How often do you fall asleep or get drowsy during class periods?					
2	How often do you get sleepy or drowsy while doing homework?					
3	Are you usually alert most of the day?					
4	How often do you get tired and grumpy during the day?					
5	How often have you trouble getting out of bed in the morning?					
6	How often do you fall back asleep after waking up in the morning?					
7	How often do you need someone to awaken in the morning?					
8	How often do you think that you need more sleep?					

b. Epworth Sleepiness Scale (ESS): Epworth Sleepiness Scale (ESS), developed by Johns (1999), is a scale intended to measure daytime sleepiness using a very short questionnaire. The scale helps identify sleep disorders. All items define a situation of daily routine. It is recommended as an instrument to recognize sleepiness levels during the daytime, which can indicate a sleep complaint or other health problem. The ESS concept was influenced by the observations of nature as well as the amount of daytime sleep and sleepiness.

Many individuals who experience significant daytime sleepiness during the day have active and decide against lying down or taking a break, purposefully escaping daytime sleeping. While others people might lie down and sleep in the daytime if they are bored, have spare time or are generally reclusive. Therefore, there may be more suitable ways to gauge their sleep than determining how often or how long people typically sleep during the day. On the other hand, sleepy persons regularly describe how they nap unintentionally, though involved in low stages of motivation, relative rigidity, and relaxation, like sitting and watching TV.

ESS is created based on stating eight situations; some situations are well-known to be very sleep-inducing, while some questions are not. According to their typical way of living in the recent past, participants were requested to answer all the items on a scale of 0-3, referring to how they dozed off or slept in the eight scenarios. There is a divergence between sleeping and simply feeling tired. However, the individual is asked to predict how each may affect them if they haven't experienced some circumstances recently. The ESS aims to get beyond the problem that individuals have different day-to-day habits, several promoting daytime sleep and others preventing it. How often the participants are dozing off while lying down to rest? is one of the questions.

Perhaps normal individuals would, while drowsy individuals definitely have a tendency to nap during that condition. Not ever doing so would specify an abnormally low level of sleepiness, defined by some insomniacs. Certain additional circumstances were involved in the questionnaire since it was assumed that the sleepiest persons would nap in them - while sitting and during a conversation with someone and in a car while stuck in heavy traffic for a few minutes. These assumptions were verified correctly. Each question in ESS is rated on a scale of 0-4 points, point 0 represents "would never doze", and point 3 represents a "high chance of dozing". All eight questions in ESS were summed together to give a total score for each individual between 0 and 24. The ESS total scores differentiate the total range of daytime sleepiness between ordinary persons and diagnostic groups. Total scores of more than 10 have sleep problems, and higher scores indicate the worst sleep quality.

<u>Epworth Sleepiness Scale (ESS)</u>

Instructions: Be as truthful as possible. Print the form. Read the situation in the first column; select your response from the second column; enter that number in the third column. Total all of the entries in the third column and enter the total in the last box.

Situation	Responses	Score
Sitting and Reading	0 = would never doze 1 = slight chance of dozing 2 = moderate chance of dozing 3 = high chance of dozing	
Watching Television	0 = would never doze 1 = slight chance of dozing 2 = moderate chance of dozing 3 = high chance of dozing	
Sitting inactive in a public place, for example, a theater or a meeting	0 = would never doze 1 = slight chance of dozing 2 = moderate chance of dozing 3 = high chance of dozing	
As a passenger in a car for an hour without a break	0 = would never doze 1 = slight chance of dozing 2 = moderate chance of dozing 3 = high chance of dozing	
Lying down to rest in the afternoon	0 = would never doze 1 = slight chance of dozing 2 = moderate chance of dozing 3 = high chance of dozing	
Sitting and talking to someone	0 = would never doze 1 = slight chance of dozing 2 = moderate chance of dozing 3 = high chance of dozing	
Sitting quietly after lunch when you've had no alcohol	0 = would never doze 1 = slight chance of dozing 2 = moderate chance of dozing 3 = high chance of dozing	
In a car while stopped in traffic	0 = would never doze 1 = slight chance of dozing 2 = moderate chance of dozing 3 = high chance of dozing	
Total score		

c. Pittsburgh's Sleep Quality Index (PSQI): The Pittsburgh's Sleep Quality Index (PSQI) was created by Buysse et al., (1989); it was developed with several goals: (I) to provide a reliable, valid, and standardized measure of sleep quality; (2) to discriminate between "good" and "poor" sleepers; (3) to provide an index that is easy for subjects to use and for clinicians and researchers to interpret; and (4) to provide a brief, clinically useful assessment of a variety of sleep disturbances that might affect sleep quality. PSQI is one of the most used sleep methods. It is used for measuring the previous month's sleep quality. This questionnaire is a time frame intermediate between post-sleep records (only sleep quality in the previous nights was measured) and survey-type forms (a problem over the previous year or more was measured). The night-to-night differences that arise in sleep quality may reveal by the post-sleep forms; however, the evidence about the occurrence or period of exact complications does not provide. Nonetheless, survey-type forms also did not specify the severity of a specific difficulty at the current period. In addition, a duration of 2-3 weeks is often used clinically to differentiate transient from persistent sleep/wake disorders (Consensus Conference on Insomnia, 1984). Consequently, measuring the PSQI differentiated the two conflicts occurrences of transitory and determined that they separated by approximately one month.

The 19 self-rated questions measure an extensive range of features involving sleep quality, such as assessments of sleep duration, sleep latency as well as the occurrence and severity of sleep-related difficulties. These 19 questions are grouped into seven component scores, and all questions are rated on a scale of 0-3. Then, the seven component scores are added together to give a global PSQI score, ranging between 0-21; higher total scores (global PSQI score) shows poor sleepers. Based on prior literature (Buysse et al., 1989), participants with a global score greater than 5 were classified as poor sleepers. A total score of 5 or less was categorized as good sleep quality. The seven components of the PSQI are uniform types of choices consistently measured with sleep/wake complaints. Each component evaluates a different aspect associated with sleep disturbance: sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction.

PSQI seven component scores

Sleep quality score: The sleep quality score signifies the quality of sleep (i.e., good or poor sleep). A higher score means poor sleep quality.

Sleep latency score: It is the length of time that it takes to complete the transition from full wakefulness to sleep (i.e., how long it takes to fall asleep).

Sleep duration score: Typically represents the total amount of sleep obtained, either during the night-time sleep period or through the 24-hour epoch.

Sleep efficiency score: It is defined as the ratio of total time spent asleep (total sleep time) in a night compared to the total amount of time spent in bed (i.e., percentage of time in bed that one is asleep).

Sleep disturbances score: It indicates a disorder of sleep pattern that may be severing enough to affect a person's normal physical, mental, and emotional functioning.

Sleep medication score: It denotes taking medicine (prescribed or over the counter) for better quality of sleep.

Daytime dysfunction score: Sleep during the daytime or the inactive period.

<u>Pittsburgh's Sleep Quality Index (PSQI)</u>

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

During the past month,

1. When have you usually gone to bed? (Usual bed time) ____________________
2. How long (in minutes) has it taken you to fall asleep each night? (Number of minutes) ________________
3. When have you usually gotten up in the morning? (Usual getting up time)___________
4. How many hours of actual sleep do you get at night? (This may be different than the number of hours you spend in bed) (Hours of sleep per night)___________________

5. During the past month, how often had you trouble sleeping because you……	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a) Cannot get to sleep within 30 minutes				
b) Wake up in the middle of the night or early morning				
c) Have to get up to use the bathroom				
d) Cannot breath comfortably				
e) Cough or snore loudly				
f) Feel too cold				
g) Feel too hot				
h) Had bad dreams				

i) Have pain				
j) Other reason(s), please describe, including how often have you had trouble sleeping because of this?				
6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?	No problem at all	Only a very slight problem	Somewh at of a problem	A very big problem
9. During the past month, how would you rate your sleep quality overall?	Very good	Fairly good	Fairly bad	Very bad

d. Cleveland Adolescent Sleepiness Questionnaire (CASQ): The CASQ was created by James et al., (2007). CASQ evaluates sleepiness and consists of 16 questions. It was created based on suggested procedures for forming a psychosocial implementation: (1) preliminary selection of questions created on experimental suggestion and concept; (2) pretesting of questions and answer arrangement for readability and conception, with measure adjustment as required; (3) management of the questionnaire to a normative model of adolescents; (4) using a split-sample method, exploratory factor analysis (EFA) to classify the fundamental measure structure on one-half of the normative sample; (5) confirmatory factor analysis (CFA) using SEM to assess the measure structure established by the EFA on the remaining half of the sample, with measure adjustment as required; (6) core consistency and strength examines employing the changed measure. Items comprise various circumstances when an adolescent might feel tired or sleepy. Numerous questions were formulated to evaluate feeling "wide awake" or "alert." A Likert scale format was used to specify the rate of every behavior happening throughout an average week: never (0 times per month); rarely (<3 times per month); sometimes (1-2 times per week); often (3-4 times per week); almost every day (5 or more times per week). CASQ answers were given a numerical value ranging from 1 = never to 5

= almost every day, and then added together to yield total score. Questions concerning alertness or feeling "wide awake" were reverse-scored before adding. The total scores range between 0-80. The CASQ higher total scores specify a greater level of sleepiness.

Cleveland Adolescent Sleepiness Questionnaire (CASQ)

Sl. No.	Questions	Never (0 times per month)	Rarely (less than 3 times per month)	Sometimes (1-2 times per week)	Often (3-4 times per week)	Almost everyday (5 or more times per week)
1	I fall asleep during my morning classes					
2	I go through the whole school day without feeling tired					
3	I fall asleep during the last class of the day					
4	I feel drowsy if I ride in a car/bike for longer than 5 minutes					
5	I feel wide-awake the whole day					
6	I fall asleep at school in my afternoon classes					
7	I feel alert during my classes					
8	I feel sleepy in the evening after school					
9	I feel sleepy when I ride in a bus to a school event like a field trip or sport games					
10	In the morning when I am in school, I fall asleep					
11	When I am in class, I feel wide-awake					

12	I feel sleepy when I do my homework in the evening after school					
13	I feel wide-awake the last class of the day					
14	I fall asleep when I ride in a bus or car					
15	During the school day, there are times when I realize that I have just fallen asleep					
16	I fall asleep when I do school work at home in the evening					

e. Morningness-Eveningness Questionnaire (MEQ): Horne and Ostberg, (1976) developed the Morningness-Eveningness Questionnaire. MEQ is based on self-reported accounts to assess when individuals prefer to perform physical and mental activities. This questionnaire consists of 19 multiple-choice questions, each with four or five response choices filled by the subjects. The questionnaire is primarily subjective, relating sleep and activity times to personal feelings best rhythm. Most responses are mandatory, with no 'do not know/cannot decide' type. For a few questions, a time scale is employed. For item analysis, all questions are assumed to have a loading factor. The MEQ scores ranged between 16 - 86, with higher scores reflecting higher morningness preference and lower scores reflecting evening type. The scores are added, and they are categorized into three types based on the total score: Morning type (MT) = 59-86, Neither type (NT) = 42-58, and Evening type (ET) = 16-41.

Morningness-Eveningness Questionnaire (MEQ)

1. What time would you get up if you were entirely free to plan your day?
   (i) 5:00- 6:30 AM (ii) 6:30- 7:45 AM (iii) 7:45- 9:45 AM
   (iv) 9:45- 11:00 AM (v) 11:00AM - 12:00 Noon
2. What time would you go to bed if you were entirely free to plan your evening?
   (i) 8:00- 9:00 PM (ii) 9:00- 10:15 PM (iii) 10:15PM- 12:30 AM
   (iv) 12:30 AM - 1:45 A M (v) 1:45 A M - 3:00 AM (vi) 3:00 –8:00 AM

3. If there is a specific time at which you have to get up in the morning, to what extent do you depend on being woken up by an alarm clock?
   (i) Not at all dependent (ii) Slightly dependent
   (iii) Fairly dependent (iv) Very dependent
4. How easy do you find it to get up in the morning (when you are not woken up unexpectedly)?
   (i) Not at all easy (ii) Not very easy
   (iii) Fairly easy (iv) Very easy
5. How alert do you feel during the first half hour after you wake up in the morning?
   (i) Not at all alert (ii) Slightly alert
   (iii) Fairly alert (iv) Very alert
6. How hungry do you feel during the first half-hour after you wake up in the morning?
   (i) Not at all hungry (ii) Slightly hungry
   (iii) Fairly hungry (iv) Very hungry
7. During the first half-hour after you wake up in the morning, how tired do you feel?
   (i) Very tired (ii) Fairly tired
   (iii) Fairly refreshed (iv) Very refreshed
8. If you have no commitments the next day, what time would you go to bed compared to your usual bedtime?
   (i) Seldom or never later (ii) Less than one hour later
   (iii) 1-2 hours later (iv) More than two hours later
9. You have decided to engage in some physical exercise. A friend suggests that you do this for one hour twice a week and the best time for him is between 7:00–8:00 am. Bearing in mind nothing but your own internal "clock", how do you think you would perform?
   (i) Would be in good form (ii) Would be in reasonable form
   (iii) Would find it difficult (iv) Would find it very difficult
10. At what time of day do you feel you become tired as a result of need for sleep?
   (i) 8:00– 9:00 PM (ii) 9:00– 10:15 PM
   (iii) 10:15 PM–12:45 AM (iv) 12:45– 2:00 AM (v) 2:00– 3:00AM
11. You want to be at your peak performance for a test that you know is going to be mentally exhausting and will last for two hours. You are entirely free to plan your day. Considering only your own internal "clock", which ONE of the four testing times would you choose?
   (i) 8:00 AM– 10:00 AM (ii) 11:00 AM–1:00 PM
   (iii) 3:00 PM– 5:00 PM (iv) 7:00 PM– 9:00 PM
12. If you got in to bed at 11:00PM, how tired would you be?
   (i) Not at all tired (ii) A little tired
   (iii) Fairly tired (iv) Very tired
13. For some reason you have gone to bed several hours later than usual, but there is no need to get up at any particular time the next morning. Which ONE of the following are you most likely to do?

(i) Will wake up at usual time, but will NOT fall back asleep
(ii) Will wake up at usual time and will doze thereafter
(iii) Will wake up at usual time but will fall asleep again
(iv) Will NOT wake up until later than usual

14. One night you have to remain awake between 4:00–6:00 AM in order to carry out a night watch. You have no commitments the next day. Which ONE of the alternatives will suite you best?
(i) Would NOT go to bed until watch was over
(ii) Would take a nap before and sleep after
(iii) Would take a good sleep before and nap after
(iv) Would sleep only before watch

15. You have to do two hours of hard physical work. You are entirely free to plan your day and considering only your own internal "clock" which ONE of the following time would you choose?
(i) 8:00 AM– 10:00 AM (ii) 11:00 AM–1:00 PM
(iii) 3:00 PM– 5:00 PM (iv) 7:00 PM– 9:00 PM

16. You have decided to engage in hard physical exercise. A friend suggests that you do this for one hour twice a week and the best time for him is between 10:00–11:00PM. Bearing in mind nothing else but your own internal "clock" how well do you think you would perform?
(i) Would be in good form (ii) Would be in reasonable form
(ii) Would find it difficult (iv) Would find it very difficult

17. Suppose that you can choose your own work hours. Assume that you worked a FIVE hour day (including breaks) and that your job was interesting and paid by results). Which FIVE CONSECUTIVE HOURS would you select?
(i) 5 hours starting between 4:00 AM and 8:00 AM
(ii) 5 hours starting between 8:00 AM and 9:00 AM
(iii) 5 hours starting between 9:00 AM and 2:00 PM
(iv) 5 hours starting between 2:00 PM and 5:00 PM
(v) 5 hours starting between 5:00 PM and 4:00 AM

18. At what time of the day do you think that you reach your "feeling best" peak?
(i) 5:00– 8:00 AM (ii) 8:00– 10:00 AM
(iii) 10:00 AM–5:00 PM (iv) 5:00– 10:00 PM (v) 10:00 PM–5:00 AM

19. One hears about "morning" and "evening" types of people. Which ONE of these types do you consider yourself to be?
(i) Definitely a "morning" type
(ii) Rather more a "morning" than an "evening" type
(iii) Rather more an "evening" than a "morning" type
(iv) Definitely an "evening" type

f. Zung Self-Rating Depression Scale (SDS): Zung Self-Rating Depression Scale was created by Zung, (1965). SDS is a short self-assessment for the measurement of the depressed status of a person. It consists of 19 questions, having four common features of depression: the pervasive effect, the physiological equivalents, other disturbances, and psychomotor activities. The scale contains nine positively worded and ten negatively worded questions. For scoring SDS, a rate of 1, 2, 3, and 4 is given to an answer based on the nature of how the question was stated, whether positively or negatively. For example, for question 1: I feel down-hearted and blue, a response of the time, or most of the time, would be rated 1, 2, 3, and 4, respectively. For question 2: Morning is when I feel the best, a response of: a little of the time, some of the time, good part of the time, or most of the time, would be rated 4, 3, 2, and 1, respectively. All questions were rated on 1 to 4 scale (a little of time, some time, a good part of time, most of the time). The total scores range between 19-76. A total score of more than 50 indicates they are mildly depressed. Higher scores mean severely depressed.

Zung Self-Rating Depression Scale (SDS)

For each item below, please place a checkmark in the column which best describes how often you felt or behaved this way during the past several days

Place check mark in correct column	A little of the time	Some of the time	Good part of the time	Most of the time
1. I feel down-hearted and blue				
2. Morning is when I feel the best				
3. I have crying spells or feel like it				
4. I have trouble sleeping at night				
5. I eat as much as I used to				
6. I notice that I am losing weight				
7. I have trouble with constipation				
8. My heart beats faster than usual				
9. I get tired for no reason				
10. My mind is as clear as it used to be				
11. I find it easy to do the things I used to				
12. I am restless and can't keep still				
13. I feel hopeful about the future				
14. I am more irritable than usual				
15. I find it easy to make decisions				

16. I feel that I am useful and needed				
17. My life is pretty full				
18. I feel that others would be better off if I were dead				
19. I still enjoy the things I used to do				

g. Yale Food Addiction Scale (YFAS): The YFAS was used to evaluate the incidence of FA. The scale consists of 25 items developed to measure "food addiction" by evaluating signs of substance-dependence symptoms in eating behavior (Gearhardt et al., 2009). All questions were rated on 0-5 scale and 8 questions contained a yes/no option. Yale Food Addiction Scale (YFAS) is the universally developed scale for the assessment of addiction to highly palatable foods with high fat and high sugar content. A symptom count of ≥3 on the YFAS denotes diagnostic criteria of food addiction (FA). The diagnostic criteria for substance requirement according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) are as follows: (1) tolerance, defined as "consuming increasing amounts of a substance to reach the similar effects or feeling reduced effects with continuous use of the same quantities"; (2) withdrawal symptoms "when the substance is not consumed or using the substance to avoid withdrawal symptoms"; (3) loss of control defined as "consuming the substance in larger quantities or over a longer period than intended"; (4) inability to cut down, defined as "a persistent desire or unsuccessful efforts to cut down substance use"; (5) much time/activity to obtain, use, or repair, that is, " an increasing efforts to gain or use the substance or its effects recovery"; (6) giving up activities defined as "reduction of social, occupational, or recreational activities because of substance use"; and (7) use, despite of negative consequences, that is, "the use of the substance despite persistent physical or psychological problems caused or exacerbated by the substance" (Association AP, 2000). In conclusion, these criteria delivered a food addiction analysis. FA was categorized as "mild," "moderate" or "severe." When 3 or more criteria are stated, a "mild diagnosis" score is assumed; then, when 4 to 5 criteria are present, a "moderate" score is gained, besides "severe" is when 6 or more criteria are determined. The YFAS instrument produces 2 variables' results. The first one is the constant assessment of validated symptoms, which is the overall amount of substance requirement signs testified by the individuals over the previous year (ranging between 0 - 7). The second is a dichotomous measure, presenting a 'diagnosis' of FA when the respondents experience 3 or more symptoms over the previous year accompanied by the "clinically significant impairment/distress" criterion (Burrows et al., 2017).

Yale Food Addiction Scale (YFAS)

This survey asks about your eating habits in the past year. People sometimes have difficulty controlling their intake of certain foods such as:
Sweets like ice cream, chocolate, doughnuts, cookies, cake, candy, ice cream
Starches like white bread, rolls, pasta, and rice
Salty snacks like chips, pretzels, and crackers
Fatty foods like steak, bacon, hamburgers, cheeseburgers, pizza, and French fries
Sugary drinks like soda pop
When the following questions ask about "CERTAIN FOODS" please think of ANY food similar to those listed in the food group or ANY
OTHER foods you have had a problem with in the past year

	IN THE PAST 12 MONTHS:	Never	Once a month	2-4 times a month	2-3 times a week	4 or more times or daily
1	I find that when I start eating certain foods, I end up eating much more than planned.	0	1	2	3	4
2	I find myself continuing to consume certain foods even though I am no longer hungry.	0	1	2	3	4
3	I eat to the point where I feel physically ill.	0	1	2	3	4
4	Not eating certain types of food or cutting down on certain types of food is something I worry about.	0	1	2	3	4
5	I spend a lot of time feeling sluggish or fatigued from overeating.	0	1	2	3	4
6	I find myself constantly eating certain foods throughout the day.	0	1	2	3	4
7	I find that when certain foods are not available, I will go out of my way to obtain them. For example, I will drive to the store to	0	1	2	3	4

	purchase certain foods even though I have other options available to me at home.					
8	There have been times when I consumed certain foods so often or in such large quantities that I started to eat food instead of working, spending time with my family or friends, or engaging in other important activities or recreational activities I enjoy.	0	1	2	3	4
9	There have been times when I consumed certain foods so often or in such large quantities that I spent time dealing with negative feelings from overeating instead of working, spending time with my family or friends, or engaging in other important activities or recreational activities I enjoy.	0	1	2	3	4
10	There have been times when I avoided professional or social situations where certain foods were available; because I was afraid I would overeat.	0	1	2	3	4
11	There have been times when I avoided professional or social situations because I was not able to consume certain foods there.	0	1	2	3	4
12	I have had withdrawal symptoms such as agitation, anxiety, or other physical symptoms when I cut down or stopped eating certain foods (Please do NOT include withdrawal symptoms caused by cutting down on caffeinated beverages such as soda pop, coffee, tea, energy drinks, etc).	0	1	2	3	4
13	I have consumed certain foods to prevent feelings of anxiety, agitation, or other physical symptoms that were developing (Please do NOT include consumption of caffeinated	0	1	2	3	4

	beverages such as soda pop, coffee, tea, energy drinks, etc.)					
14	I have found that I have elevated desire for or urge to consume certain foods when I cut down or stop eating them.	0	1	2	3	4
15	My behavior with respect to food and eating causes significant distress.	0	1	2	3	4
16	I experience significant problems in my ability to function effectively (daily routine, job/school, social activities, family activities, health difficulties) because of food and eating.	0	1	2	3	4
					NO	YES
17	My food consumption has caused significant psychological problems such as depression, anxiety, self-loathing, or guilt.				0	1
18	My food consumption has caused significant physical problems or made a physical problem worse.				0	1
19	I kept consuming the same types of food or the same amount of food even though I was having emotional and/or physical problems.				0	1
20	Over time, I have found that I need to eat more and more to get the feeling I want, such as reduced negative emotions or increased pleasure.				0	1
21	I have found that eating the same amount of food does not reduce my negative emotions or increase pleasurable feelings the way it used to.				0	1
22	I want to cut down or stop eating certain kinds of food.				0	1
23	I have tried to cut down or stop eating certain kinds of food.				0	1
24	I have been successful at cutting down or not eating these kinds of food.				0	1
25	How many times in the past year did you try to cut down or stop eating certain foods altogether?	1 or fewer times	2 times	3 times	4 times	5 or more times

<u>h. Actigraphy</u>: Wrist actigraphy is a non-invasive method of monitoring participants' rest-activity cycles, which is most commonly used in sleep and circadian rhythm research (Ancoli-Israel et al., 2003). In several studies, actigraphy is widely used to confirm the measurement of individuals adhering to the recommended sleep/wake rhythm. It is a wrist-watch-like device, generally worn on the non-dominant hand, to evaluate rest-activity cycles with the accelerometer. Then, the computer algorithms are administered for activity counts that use determined thresholds to mark each epoch as "sleep" or "wake." The Actiwatch 2 incorporates watch bands and can charge battery, communication, and software upgrades like an automatic rest algorithm and an ambient light sensor. The device was made to offer 24/7 wearability and correct statistics collection. It was designed and verified to resist environmental circumstances like cold, heat, dust, sweat, and water. Actiwatch 2 can automatically collect and store data for sleep parameters to study circadian rhythms and measure activity in several orders where an assessable investigation of the physical signal is preferred. Actigraphy can be a valuable tool for evaluating insomnia, particularly because people with insomnia have a greater propensity for misperceiving their sleep time than individuals without insomnia and overall tend to significantly underestimate sleep time (Means et al., 2003).

Philips Respironics Actiwatch 2 was used in the study, and a device was worn for recording activities and used to assess sleep parameters. All the participants were requested not to remove the watch during the recording period except when they went for a bath before the beginning of the study. The movement was continuously measured and recorded in 1-minute epochs all through 24-hours days for three consecutive days of the study period. The actiwatch 2 is intended for recording physical activities which are linked with physiological monitoring. The definition of sleep/wake statistics on the actigraphy reports are as follows:

Bed-time: It is defined as the time when the subject went to bed with the intent to sleep.

Get-up time: It refers to the time when the subject rises from bed for the final time.

Time in bed (TIB): Time in bed indicates time between bed-time and get-up time.

Total sleep time (TST): It represents total time within rest intervals scored as sleep.

Sleep onset latency (SOL): It refers to the time between bed-time and sleep start time.

Sleep efficiency (SE): It states the percentage of time in bed spent for sleeping.

Wake after sleep onset (WASO): Wake after sleep onset is the number of waking minutes between sleep start and end times.

Mid-sleep time: It signifies the halfway point between sleep time and wake-up time.

Statistical analysis

Data obtained from various studies were further analyzed statistically. To compare values at two-time points, the student's t-test was used. One-way analysis of variance (One-way ANOVA), followed by Newman-Keuls multiple comparisons test and Tukey's multiple comparisons test, was employed for group comparisons. Significance was always taken at $P < 0.05$. All the statistical analysis was done using graph pad Prism version 8.

SECTION 1. TO STUDY SLEEP DURATION AND SLEEP QUALITY

ABSTRACT

Sleep is a fundamental part of the body's daily cycle. It is essential for proper physical development, emotional strength, performance, and even to maintain mental functioning among school students. The relationship of short sleep duration and sleep disorders to the deprived performance of the body's daily responsibilities have been reported by observational and experimental studies. This study aimed to examine sleep duration and sleep quality among school students of Mizo population, a population living in North-East part of India and inhabiting a high altitude. Our study included total 900 school students (409 male and 491 female participants). A different self-administered questionnaire was used in the study, Morningness-Eveningness Questionnaire (MEQ), Pittsburgh's Sleep Quality Index (PSQI), Pediatric Daytime Sleepiness Scale (PDSS), Epworth Sleepiness Scale (ESS), Cleveland Adolescent Sleepiness Questionnaire (CASQ), and Zung Self-Rating Depression Scale (SDS). Their sleep/wake patterns were recorded using armband actigraphy. The results show NT students dominated the study population. Participants of ET shows poor sleep quality, more daytime sleepiness, and higher self-rating depression level. The majority of school students reported 7.00 – 7.90 hours of sleep duration. Differential actigraphy report was observed among the three chronotypes with poor sleep quality among ET participants. These are probably the first reports from the population inhabiting a high altitude and could be potentially used for forming the policies for school students.

INTRODUCTION

Sleep is a basic biological process and is essential for the growth and healthy development of children and adolescents (Gazini et al., 2012). The amount of sleep duration varies depending on age, gender, and other factors. It is deliberated as an essential concern for the well-being of adolescents. Short sleep duration is associated with neuroendocrine and metabolic modifications, including decreased levels of leptin, glucose tolerance, insulin sensitivity, and increased levels of ghrelin, hunger, and appetite (Bornhorst et al., 2012). Moreover, evidence suggests the linkage between short sleep and specific behavior, such as low physical activity and low consumption of fruit and vegetables (Stamatakis and Brownson, 2008). Various studies discovered the connection between the duration of sleep and obesity. Several cross-sectional studies have reported that short sleep duration is associated with childhood obesity (Shi et al., 2010; Martinez et al., 2014; Chaput et al., 2011; Kong et al., 2011; Hitze et al., 2009). Sleep duration changes as a child grows to adulthood and generally decreases when children get older (Shi et al., 2010). In addition, poor sleep quality has direct repercussions on daytime activities performed by children and adolescents (Beebe, 2011). Adolescence is a developmental period characterized by substantial changes in sleep patterns, including declines in the average duration of night-time sleep, increases in sleep disturbances, and more irregular sleep patterns (Dahl and Lewin, 2002).

Physiological studies have shown that adequate sleep is also important for memory consolidation, seriously affecting school success in this age group (Meldrum and Restivo, 2014; Allen-Gomes et al., 2011). A good quality of sleep reflects better school performance and increased motivation to study (Allen-Gomes et al., 2011). Several studies suggest that the population requires an average of eight to nine hours of sleep per night to adequately perform everyday activities and absorb the physical and mental benefits of sleep (Dewald et al., 2010; Owens, 2014). Although this is the goal for good-quality sleep, it is known that adolescents have been sleeping for shorter periods than necessary (Matricciani et al., 2012). The upgrading and launching of increasingly more attractive video games and virtual reality simulators and the broad presence of the internet through chat groups and social networks are aggravating factors for inadequate sleep (Calamaro et al., 2009). The presence of TVs, video game consoles, and computers in bedrooms (Calamaro et al., 2009; Cain and Gradisar, 2010; Van den Bulck, 2004) are related to more significant sleep deprivation. Moreover, the hectic lifestyle, especially in large cities, negatively affects adolescents, making them victims of anxiety, aggression, stress, and social and school burdens, possibly damaging adequate sleep (Meldrum and Restivo, 2014; Shochat et al., 2014). More than earlier believed. sleep deficiency is not controlled by psychosocial variations. Overweight adolescents appear to have shorter and more disturbed sleep (Hart et al., 2011; Mitchell et al., 2013), and overweightness is also a risk factor for sleep-disordered breathing, such as obstructive sleep apnea syndrome (OSAS) (Bhattacharjee et al., 2011). The current understanding is that both internal factors, such as sexual maturity, age, gender, and obesity, as well as external factors, such as school shifts, use of technology and drug, can influence sleep (Owens et al., 2014; Calamaro et al., 2009).

The duration of sleep among children is directed by their social backgrounds and biological features. There are essential differences in the sleep duration of residents of different countries (Jenni and O'Connor, 2005; Liu et al., 2005), and there is a steady reduction of sleep duration between ages 1 and 20 years (Iglowstein et al., 2003; Russo et al., 2007). The adolescent’s chronotype primarily rests on biological aspects. From age 10 to 20, there is a phase delay in the sleep/wake rhythm (Carskadon et al., 1993; Giannotti et al., 2002; Roenneberg et al., 2004; Tonetti et al., 2008). The adaptation of late chronotype children to the social environment is difficult. As a result, they may have lower school achievements (Carskadon et al., 1995), psychological problems, and deviant behavior (Gau et al., 2007; Yokomaku et al., 2008). One of the probable reasons for the negative effect of the school schedule on persons with late chronotype is an insufficient amount of sleep (Medeiros et al., 2001). Among adolescents, the phase interval effects of biological factors have been well known; however, the impact of social features on morningness-eveningness still needs to be investigated. Numerous studies have shown that parental control over adolescents' bed-time and get-up time was less normal in older adolescents than in children (e.g. Carskadon, 2002; Gau and Soong, 1995; Giannotti et al., 2002). Sleep patterns among adolescents have been associated with several socio-demographic characteristics. Age and puberty-related declines in sleep duration, delays in chronotype, and increases in social jetlag have been consistently reported (Knutson, 2005; Olds et al., 2010).

Several studies have demonstrated that a lack of sleep increases the possibility of gaining weight and suffering from obesity due to different mechanisms that affect food intake and energy expenditure (Patel and Hu, 2008; Fenton et al., 2020). Additionally, good sleep quality is known to be essential for maintaining correct metabolic health and lower cardiovascular disease risk (Sofi et al., 2014). Furthermore, sufficient duration and good quality of sleep are directly related to a regular body composition index, less depressive symptoms, and better sports performance (Chang and Chen, 2015). Adequate sleep quality also ensures a positive emotional, physical, and cognitive balance, and even correct physical recovery, reducing the risk of over-training and improving the rest and post-exercise recovery processes (Erlacher et al., 2011; Fullagar et al., 2015; Mata-Ordoñez et al., 2018).

Among adolescents, sleep quality and duration are categorized by a clear reduction (National Research Council (US) and Institute of Medicine (US) Forum on Adolescence, 2000; Bruce et al., 2017; Millman, 2005). Sleep disorders in adolescents have received significant attention due to their high prevalence and their negative effects on health outcomes (Ji and Liu, 2016). Cross-sectional studies conducted on adolescent populations report sleep disorders and deterioration of daytime functions due to poor sleep quality or insufficient sleep (Cheng et al., 2020). The analysis of both sleep quality and duration among adolescents has been done by previous studies. For example, Bel et al., (2013) studied the sleep duration of 1522 adolescents between 12 and 17 years. In this study, only 29.0% of the participants met the recommendations for daily sleep hours. Another study on sleep quality in adolescents (Ferranti et al., 2016), determined that only 47.0% of the subjects reported duration of sleep following recommendations and that, in addition, those who slept less had higher rates of overweight or obesity. Numerous studies agree that low quality and short duration of sleep are directly related to bad dietary behaviors, low levels of physical activity, and unhealthy habits, resulting in reduced quality of life (Gong et al., 2017; Tambalis et al., 2018; Beşoluk, 2018).

Several platforms have been established to alert the effect of inadequate sleep or poor sleep quality among adolescents. In general, adolescents prefer to retire and rise late, significantly when their melatonin release is delayed during puberty (Carskadon and Acebo, 1997). This preference is reflected by later bed-times and longer sleep durations on holidays or weekends (Warner et al., 2008; Loessl et al., 2008; Gibson et al., 2006; Wolfson and Carskadon, 1998; Wolfson, 2003). Studies have shown that the average duration of sleep among adolescents has declined in the past three decades because they have been engaged in activities that reduce their sleep time (Kubiszewski et al., 2014; Sarchiapone et al., 2014; Colrain and Baker, 2011). Accordingly, insufficient sleep or irregular sleep pattern has been related to a number of health problems. For instance, adolescents who have abnormalities of cognitive performance and behavior (Sarchiapone et al., 2014; Colrain and Baker, 2011), and depression (Sivertensen et al., 2014) are more likely to have common illnesses such as gastroenteritis and common cold (Orzech et al., 2014). Among adolescents and even spreading into adulthood, these disorders can considerably increase tension and cause long-term adverse effect. Several efforts have been made to diminish these tensions, and also the prevention of their incidence is valuable to support a stress-free among adolescence. Though the previous findings have been led to study sleep and associated challenges among school students, most of these studies have been limited to the European or American population. Minimal knowledge is available for the Indian population, especially with the people living at high altitudes. Aizawl, Mizoram, is at an altitude of 800 to 1200 meters from sea level. Therefore, the specific aim of this study was to observe sleep duration and sleep quality among school-going students of Aizawl, Mizoram, inhabiting a high altitude.

MATERIALS AND METHODS

The study involved total of 900 school students, out of which 409 were males and 491 were female participants, and their age group ranged between 14 to 20 years. Self-administered questionnaires were used. Morningness-Eveningness Questionnaire (MEQ) was used for the assessment of chronotype, Pittsburgh's Sleep Quality Index (PSQI) was employed to evaluate the sleep quality, sleep duration, and different sleep habits, Pediatric Daytime Sleepiness Scale (PDSS) was used for the measurement of daytime sleepiness, Epworth Sleepiness Scale (ESS) was applied to measure a person's sleepiness level, Cleveland Adolescent Sleepiness Questionnaire (CASQ) evaluated sleepiness, and Zung Self-Rating Depression Scale (SDS) was used to identify the level of depression. Further, their sleep/wake patterns (456 participants, 216 male, and 240 female) were recorded using actigraphy.

Statistical analysis

Data are presented as mean ± SE. One-way analysis of variance (One-way ANOVA) was used to analyze data, followed by Tukey's multiple comparisons test to check differences among the groups. $P < 0.05$ was considered as significant in difference.

RESULTS

To categorize the underlying chronotype classes, we executed Horne and Ostberg Morningness-Eveningness Questionnaire (MEQ) with all 19 items. The percentage of chronotype was analyzed among the overall participants. In our study group, the percentage of NT was highest (66.6%), followed by MT (26.4%), while ET participants were the minimum (only 7.0%; Fig. 1).

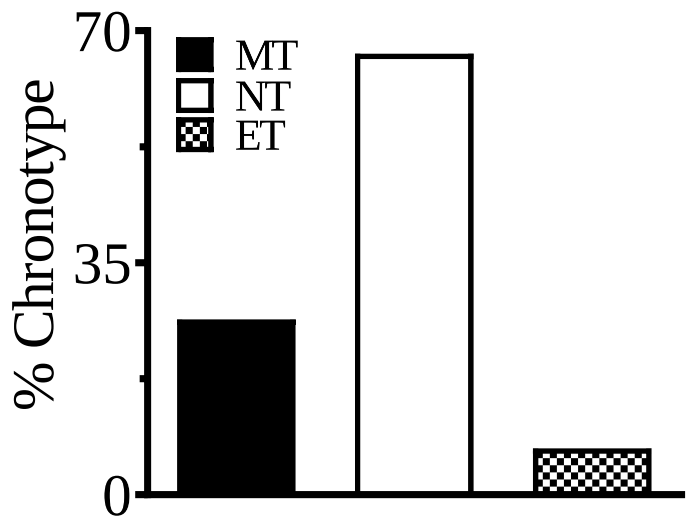

Figure 1: Data is represented as percentage. Percentage of MT, NT and ET among school students.

Sleep duration percentage of all participants among school students was calculated (Fig. 2). Only 3.2% of students reported less than 5.00 hours of sleep, 13.2% slept between 5.00 to 5.90 hours, 22.5% slept between 6.00 to 6.90 hours, 31.8% reported sleep 7.00 to 7.90 hours, 20.2% slept between 8.00-8.90 hours, and 8.8% of students reported more than 9.00 hours of sleep.

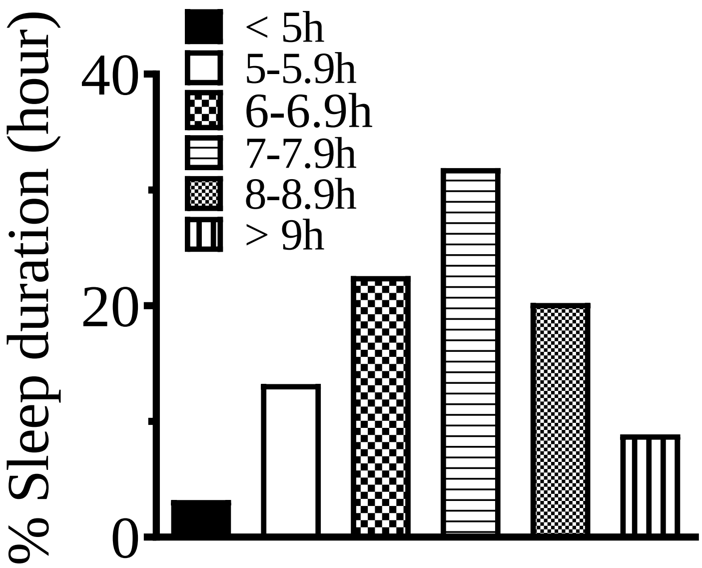

Figure 2: Data is represented as percentage. Percentage of sleep duration among school students.

Pittsburgh's Sleep Quality Index (PSQI)

Figure 3 shows the global PSQI score and different sleep habits of PSQI scores among MT, NT, and ET participants. There were significant differences in the global PSQI score among the three chronotypes ($F_{2,897}$= 17.38, $P < 0.0001$; 1-way ANOVA; Figure 3a). ET (7.2±0.4) participants showed the highest score ($P < 0.05$; Tukey's multiple comparisons test) as compared to MT (5.2±0.1), and NT (6.1±0.1).

Except for the score of sleep disturbances ($F_{2,895}$= 1.207, $P = 0.2995$; One way ANOVA; Fig. 3h), there was a significant difference in all sleep properties studied (bed-time: $F_{2,897}$ = 80.00, $P < 0.0001$; Fig. 3b; get-up time: $F_{2,897}$ = 84.48, $P < 0.0001$; Fig. 3c; sleep quality: $F_{2,897}$ = 16.95, $P < 0.0001$; Fig. 3d; sleep latency: $F_{2,897}$ = 11.46, $P < 0.0001$; Fig. 3e; sleep duration: $F_{2,892}$= 5.169, $P = 0.0059$; Fig. 3f; sleep efficiency: $F_{2,893}$= 4.826, $P = 0.0082$; One way ANOVA; Fig. 3g; daytime dysfunction: $F_{2,894}$= 4.149, $P = 0.0161$; One way ANOVA; Figure 3i). In comparison to MT, both ET and NT had delay in bed-time and get-up timing ($P < 0.05$; Tukey's multiple comparisons test; Fig. 3b,c). Further, in comparison to NT, ET also showed delay in bed and get-up timing ($P < 0.05$; Tukey's multiple comparisons test; Fig. 3b,c). The scores of sleep quality and sleep latency was highest in ET compared to MT and NT, with the highest score in ET followed by NT and MT, respectively (Fig. 3d,e). Sleep duration score was significantly longer in ET and NT than MT, but there was no difference between ET and NT (Fig. 3f). Similarly, the scores of sleep efficiency and daytime sleep dysfunction were higher in ET and NT than MT, with no differences in ET and NT (Fig. 3g,i).

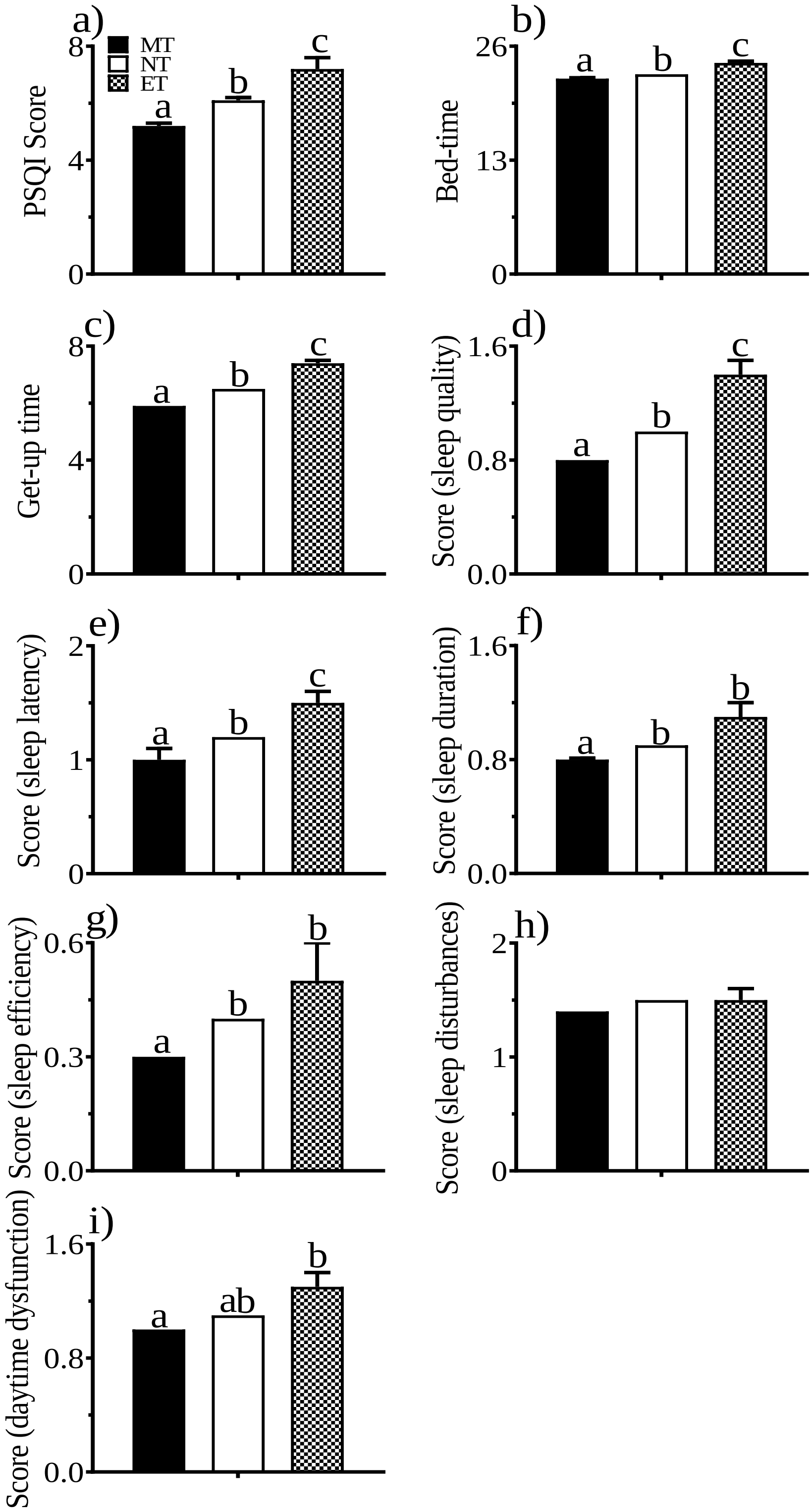

Figure 3: Data is represented as mean ± SE. Comparison of global PSQI score and different sleep habits between MT, NT and ET. Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes.

Pediatric Daytime Sleepiness Scale (PDSS)

PDSS analysis shows the effect of chronotype on PDSS scores ($F_{2,897}$= 25.27, $P < 0.0001$; One way ANOVA; Fig. 4). Among the three chronotypes, ET participants showed maximum scores (16.9±0.7), followed by NT (14.8±0.2) and MT (12.7±0.3). MT participants had minimum daytime sleepiness, as reflected by the PDSS score (Fig. 4).

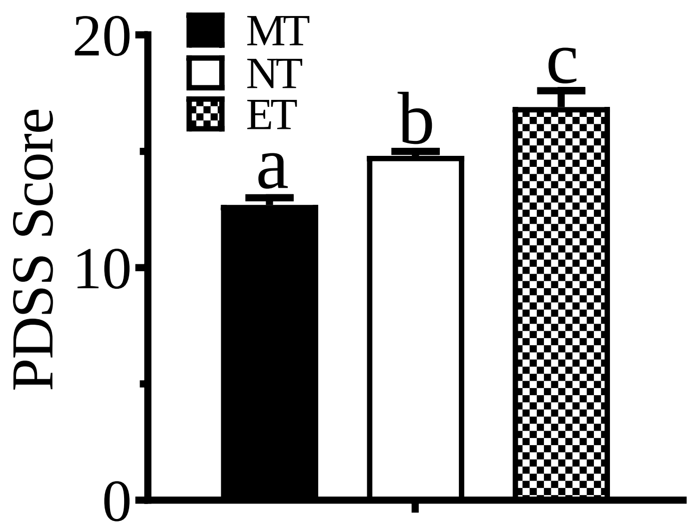

Figure 4: Data is represented as mean ± SE. Comparison of PDSS scores between MT, NT and ET. Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes.

Epworth Sleepiness Scale (ESS)

Like PDSS, ESS also showed chronotype dependent effect ($F_{2,897}$= 13.07, $P < 0.0001$; One way ANOVA; Fig. 5). Among the three chronotypes, ESS scores was highest in ET (10.0±0.5), followed by NT (8.1±0.2), while MT had significantly lower scores (7.3±0.2) than ET and NT (Fig. 5).

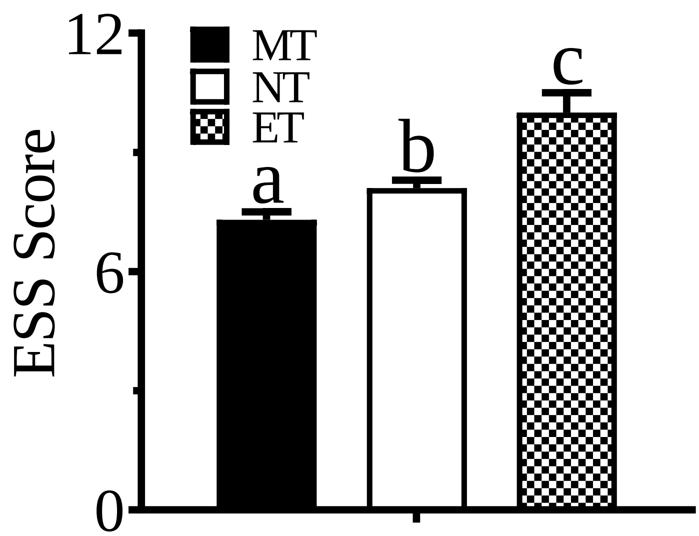

Figure 5: Data is represented as mean ± SE. Comparison of ESS scores between MT, NT and ET. Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes.

Cleveland Adolescent Sleepiness Questionnaire (CASQ)

CASQ scores was significantly different among the three chronotypes ($F_{2,897}$= 10.60, $P < 0.0001$; One way ANOVA; Fig. 6). Highest sleepiness scores was observed in ET (44.3±1.2), followed by NT (41.6±0.3), and MT (39.8±0.5). Among the three chronotypes, MT participants had a minimum sleepiness scores (39.8±0.5; Fig. 6).

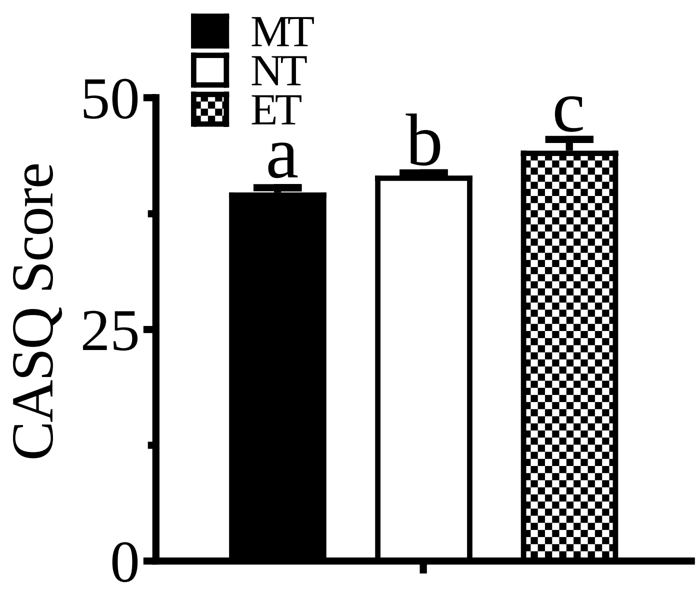

Figure 6: Data is represented as mean ± SE. Comparison of CASQ scores between MT, NT and ET. Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes.

Zung Self-Rating Depression Scale (SDS)

A significant effect of chronotype on self-reported depression levels was observed ($F_{2,589}$= 15.54, $P < 0.0001$; One way ANOVA; Fig. 7). Among the three types, ET participants reported the highest depression level (45.5±0.8), followed by NT (43.2±0.3), and MT (40.2±0.2). A minimum depression level was observed in MT participants (Fig. 7).

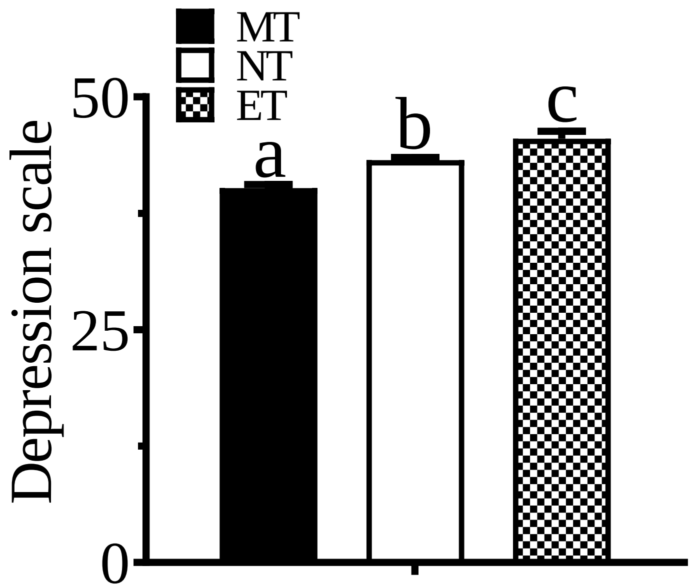

Figure 7: Data is represented as mean ± SE. Comparison of SDS between MT, NT and ET. Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes.

Actigraphy

Figure 9 shows comparison of actigraphy reports between MT, NT, and ET. There was a significant difference in the bed-time ($F_{2,85}$= 10.35, P < 0.0001; One way ANOVA; Fig. 9a), and get-up time ($F_{2,88}$= 8.808, P = 0.0003; One way ANOVA; Fig. 9b) among the three chronotypes. MT participants had early bed-time (22.4±0.2) and get-up time (6.5±0.3) in comparison to ET bed-time (1.1±0.5) and get-up time (8.6±0.6) and NT bed-time (23.5±0.2) and get-up time (7.8±0.2), while the ET participants were highest delayed both for bed-time (1.1±0.5; Fig. 9a), and get-up time (8.6±0.6; Fig. 9b).

There was a significant difference between time in bed ($F_{2,80}$= 5.703, P = 0.0084; One way ANOVA; Fig. 9c), total sleep time ($F_{2,85}$= 3.746, P = 0.0276; One way ANOVA; Fig. 9d), sleep onset latency ($F_{2,117}$= 18.28, P < 0.0001; One way ANOVA; Fig. 9e), wake after sleep onset ($F_{2,86}$= 3.117, P = 0.0493; One way ANOVA; Fig. 9g), and mid-sleep time ($F_{2,160}$= 14.59, P < 0.0001; One way ANOVA; Fig. 9h). In comparison to MT, NT had significantly longer time in bed (P < 0.05; Tukey's multiple comparisons test; Fig. 9c). However, there was no difference in time in bed between ET and MT, and ET and NT (Fig. 9c). Total sleep time was significantly longer in NT in comparison to MT (Fig. 9d), however no difference between ET and MT, and ET and NT was observed (Fig. 9d). Sleep onset latency was significantly higher in NT, followed by ET and MT (Fig. 9e). Significantly lower wake after sleep onset was observed in ET than MT and NT (Fig. 9g). Higher mid-sleep time was observed in NT, significant difference was not observed between MT and ET, while there was a significant difference between MT and NT, and NT and ET (Fig. 9h). However, there was no difference in sleep efficiency ($F_{2,89}$= 1.965, P = 0.1469; One way ANOVA; Fig. 9f).

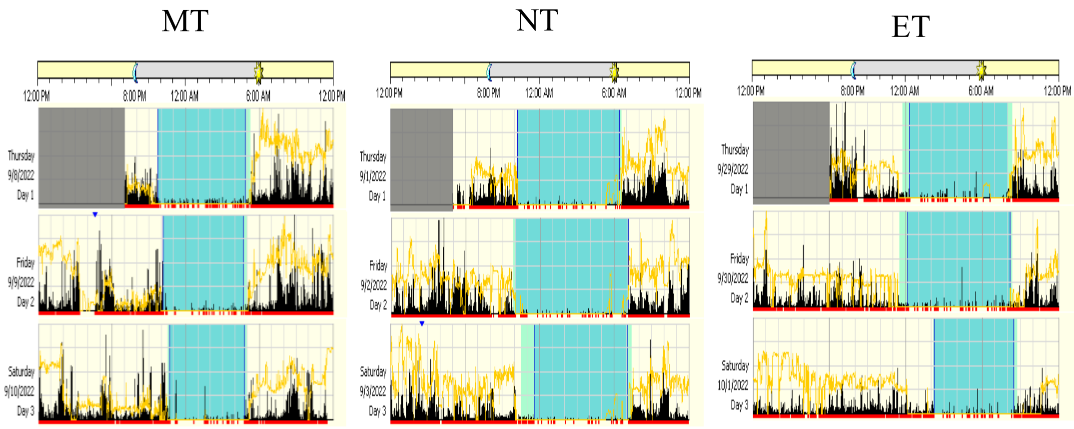

Figure 8: Representative actogram of MT, NT and ET

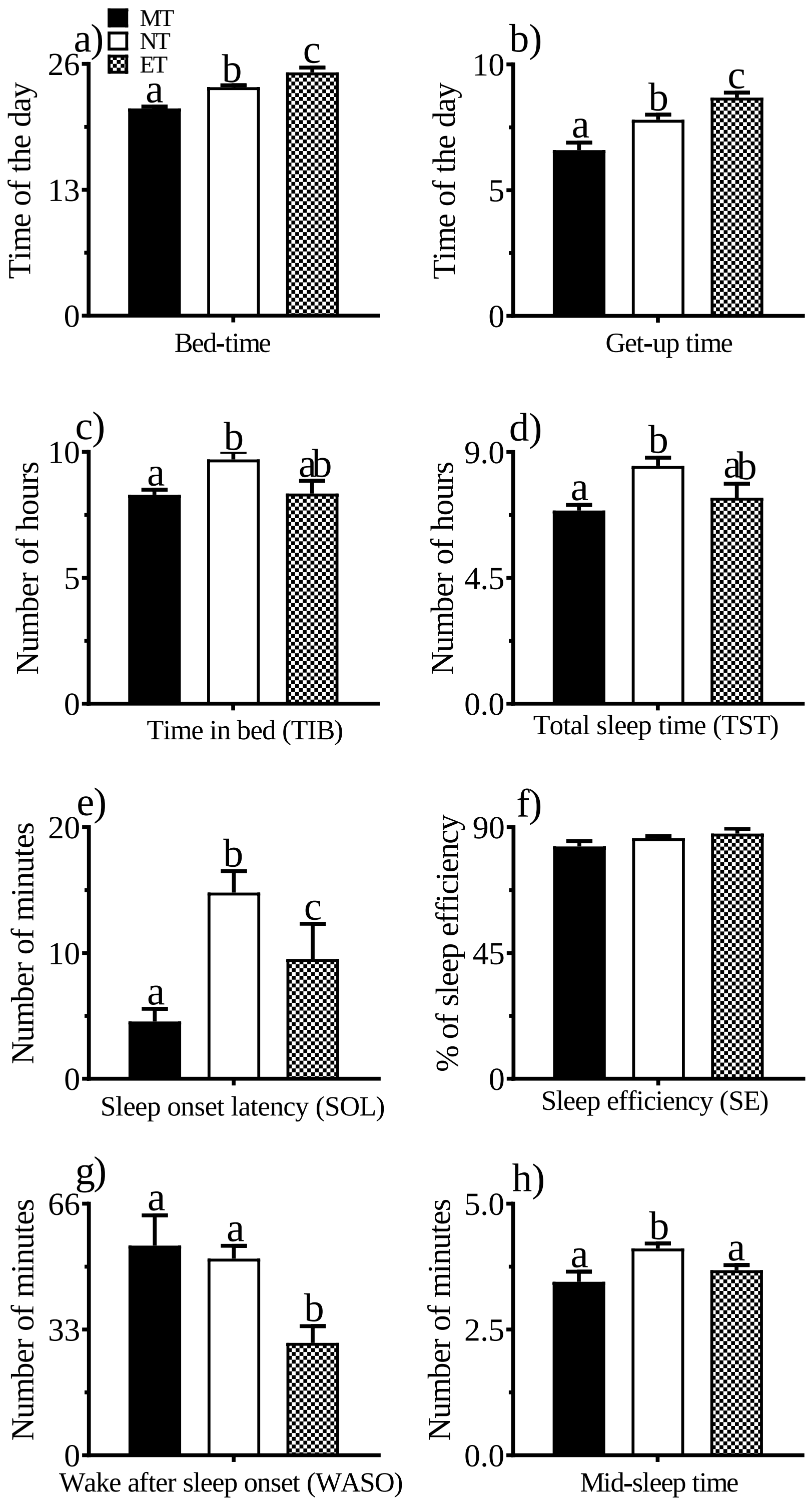

Figure 9: Data is represented as mean ± SE. Comparison of actigraphy report between MT, NT and ET. Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes.

DISCUSSION

The study examined a range of variables affecting sleep and mental health among school students. These variables include self-reports of sleep (PSQI, ESS, PDSS, and CASQ) and mental and physical well-being (SDS). In our study, among school students, the highest percentage is of NT, followed by MT and ET (Fig. 1). The dominance of NT individuals in the population is consistent with other previous reports (Li et al., 2018). The relationship between age and chronotype (Carrier et al., 1997; Paine et al., 2006) has been reported in previous studies. In general, teens tend to exhibit eveningness (Caci et al., 2005; Randler and Bilger, 2009), whereas morningness is greater as age progresses (Carrier et al., 1997; Paine et al., 2006). Our findings differ from previous reports, which suggest that the morningness-eveningness preference of children is shifting from MT towards ET in the early puberty stage (Kim et al., 2002; Randler et al., 2014; Roenneberg et al., 2004). The current study age group included the ranges from 14 to 20 years, and in comparison to ET, a higher percentage of MT (Fig. 1) was observed. The various factors, such as the availability of lights, new information, and communication technologies, and mainly modern lifestyle, dominate the sleep/wake schedules and overall sleep length of individuals, thus increasing the amount of ET individuals (Vollmer et al., 2012). The potential reason for differences from these previous studies could be the lifestyle of students of Mizoram. The study participants were school students of the municipal area of Aizawl city, the capital of Mizoram, a North-East state of India. Although it is a capital city, unlike other metro cities, there are limited clubs, movie theatres, few malls, and industries.

Further, shift work-related jobs are limited to nursing and security people, and therefore nightlife is very limited in Mizoram. Another crucial point is that the regular business hours in the city are limited to the early evening hours. Therefore, the resident's lifestyle could be the significant reason for fewer ET than MT (Fig. 1).

The present study identified a longer duration of sleep, better sleep quality, and greater sleep reliability among school students. 31.8% of school students reached 7.00 - 7.90 hours of sleep duration, and it was the highest percentage of sleep duration (Fig. 2). Epidemiological studies usually defined self-reported short and long sleep duration as less than 6.00 or 7.00 hours per day, and more than 8.00 or 9.00 hours per day, respectively (Bin et al., 2013; Silva et al., 2016; Kalmbach et al., 2016; Gallicchio and Kalesan, 2009). In our study, the mean total sleep duration was 6.9±0.0 hours, with no difference in male and female participants (male mean sleep duration was 6.9±0.1 hours, and female mean sleep duration was 7.0±0.1 hours). Previous studies reported reduced sleep timing in children and adolescents over the past century (Basch et al., 2014; Matricciani et al., 2012). Adolescents are recommended 8.00 - 10.00 hours of sleep each night (Hirshkowitz et al., 2015), but epidemiological studies from the United States revealed that a significant percentage of adolescents sleep lesser than 7.00 hours on an average school night (Basch et al., 2014; Taveras et al., 2008). Only a small percentage of student populations having sleep more than 9.00 hours on an average school night (Hirshkowitz et al., 2015). Further, studies also suggest that the optimal sleep duration differs for different developmental outcomes among adolescents (Fuligni et al., 2018). For example, adolescents who slept 8.75-9.00 hours per night had peak levels for mental health, while adolescents having 7.00-7.50 hours of sleep duration affected academic success (Fuligni et al., 2018). Sleep is an important component of memory consolidation and creativity, and sleep deprivation can lead learning, along problems with concentration and discipline (Kryger et al., 2011). However, some other studies suggested 7.00 to 8.00 hours of sleep per day as appropriate for students, whereas fewer than 7.00 hours is defined as short sleep, and more than 8.00 hours is regarded as long sleep (Steptoe et al., 2006; Grandner and Kripke, 2004). The National Sleep Foundation has recommended 7.00 to 9.00 hours per day as an appropriate sleep duration for young adults (Hirshkowitz et al., 2015). Irregular sleep/wake patterns and poor sleep quality are associated not only with increased tiredness but also with significant effects on endocrinology, immunology, and metabolism status (Akerstedt and Nilsson, 2003; Li et al., 2015). Sleep-deprived students usually perform significantly worse than those with normal sleep (Warner et al., 2008; Pilcher and Walters, 1997). In addition, short sleep duration is associated with unhealthy risk behaviors, such as alcohol and tobacco use, which could increase the risk of developing hypertension, obesity, diabetes, hypercholesterolemia, and even mortality (Watanabe et al., 2010; Vgontzas et al., 2009; Lin et al., 2016; Wheaton et al., 2016;

Itani et al., 2017; Liu et al., 2017). In contrast, long sleep duration can also be associated with negative outcomes, such as increased risk of cardiovascular disease and cognitive impairment (Bin et al., 2013; Shankar et al., 2008; Ferrie et al., 2011).

Various sleep parameters and depression levels were assessed, and chronotype-dependent effects were observed in this study (Fig. 3 - 7). MT shows better sleep quality and minimum self-rating depression levels, whereas ET individuals show the poorest sleep quality and maximum self-rating depression levels. These findings are consistent with the previous reports where ET adolescents have been suggested to be more prone to sleep disturbances, including insomnia (Alvaro et al., 2014; Giannotti et al., 2002). In addition, ET adolescents are associated with various social and physiological adverse outcomes, including increased health-related risk behaviors, emotional and behavioral issues, poor life quality, and an elevated risk for suicidality (Alvaro et al., 2014; de Souza and Hidalgo, 2014; Gau et al., 2007; Giannotti et al., 2002). Available literature from human studies suggests that the conditions leading to disturbed circadian rhythm, like late-night sleep and often awakening, can negatively affect sleep quality. Impaired circadian rhythm alters sleep/wake habits that lead to low sleep quality (Gangwar et al., 2018; Rawat et al., 2019).

The actigraphy report of school students was analyzed based on chronotype (Fig. 9). Delay in the bed-timing and get-up time was observed among ET (Fig. 9a,b). In time in bed, total sleep time, sleep onset latency, and mid-sleep time, the highest number was identified among NT (Fig. 9c,d,e,h). The study observed that the total time awake at night was lowest among ET (Fig. 9g). Actigraphy has been recognized as a tool capable of diagnosing circadian rhythm sleep disorders (Morgenthaler et al., 2007). The association between sleep quality and chronotype has been shown by the result of previous studies. A study conducted among Brazilian medical students shows that the ET individuals had worse sleep quality when compared with the MT (Riquen et al., 2014). Another study involving 264 university students had similar results and identified the relationship between poor sleep quality and ET (Selvi et al., 2012). Similar results have also been reported in other studies (Koskenvuo et al., 2007; Barclay et al., 2010; Megdal and Schernhammer, 2007; Shiihara et al., 1998; Vardar et al., 2008).

Though delay in sleep timings among adolescents appears to be an everyday life in the growth of adolescents. Among the ET students, the decline in sleep quality may be because of the misalignment between internal sleep/wake cycles, as they need to wake-up early due to school timing. Attempts to initiate sleep at an earlier clock time may result in prolonged sleep onset times (Eid et al., 2020). The accumulated sleep debt during a school day is compensated during weekends (Crowley et al., 2018). Then, the exposure to morning natural light has been reduced, and therefore the circadian rhythm has been delayed due to untimely resetting and synchronizing body clock timing. However, several other factors have also been identified to contribute to a late chronotype, including homeostatic sleep pressure, circadian length, phase angle of entrainment, exposure and sensitivity to light (Mongrain et al., 2004; Mcglashan et al., 2018; Micic et al., 2016; Micic et al., 2015). In our study, a stronger morning preference (MT participants) corresponded to earlier sleep-onset and -offset times (Fig. 9). However, in participants with evening preference (ET), get-up time and bed-time were delayed (Fig. 9). Our results are corresponding to the previous reports (Paciello et al., 2022). This study shows ET students are having higher scores of CASQ, ESS, and PDSS, suggesting compromised sleep quality (Fig. 4-6). Compared to MT, the sleep parameters of these ET students are compromised (Fig. 9). Daytime sleepiness is mainly predicted by the worst sleep quality and eveningness than the time in bed. Similar findings have been reported among Brazilian school students (Anacleto et al., 2022).

In summary, our study suggests that in comparison to ET, MT participants proposed the importance of having an awareness of proper sleep among students. Further, a significantly higher percentage of students having proper sleep (7.00 to 9.00 hours) is another indicator of adequate sleep among the majority of students. Among adolescents, there is a greater need to support growing healthy sleep habits. Importantly, insufficient sleep may lead to attention deficits, lack of concentration, reduced cognitive abilities, and risk-taking behaviors (Kryger et al., 2011). Chronic sleep insufficiency in adolescents is probable because of the combination of changes in puberty, school timing, and after-school commitments, as well as lifestyle behaviors, which include the irregular bed-time routine and frequent use of technology that can cause severe health problems and growing consequences. There is a need to encourage adolescents to use their bodily cues to indicate when it is time for bed rather than relying on external cues (Short et al., 2019).

SECTION 2. TO STUDY GENDER DIFFERENCES IN SLEEP HABITS, SLEEP QUALITY, AND DAYTIME SLEEPINESS

ABSTRACT

Males and females sleep differently. Although some of the mechanisms that drive sleep are known, the reason for these gender differences in sleep behavior is unidentified and understudied. However, the recognition of sex disparities in sleep and rhythm disorders is increasing. Sex differences in the quantity and quality of sleep are shown in several studies, with females stating more complaints of sleep deprivation than males. Therefore, the present study examined gender differences in sleep patterns among school students. The study consists of total participants 900 school students (409 male and 491 female). Age of the participants ranged between 14-20 years. A self-administered Morningness-Eveningness Questionnaire (MEQ), Pittsburgh's Sleep Quality Index (PSQI), Pediatric Daytime Sleepiness Scale (PDSS), Epworth Sleepiness Scale (ESS), Cleveland Adolescent Sleepiness Questionnaire (CASQ), and Zung Self-Rating Depression Scale (SDS) was used in the study. Armband actigraphy was employed to record sleep/wake patterns. Our study reveals gender-based differences in sleep patterns as well as in the self-rating depression levels. Males, in comparison to females, tend to lean more towards eveningness. More daytime sleepiness and high self-rating depression levels were observed among females. A significant difference was also found in the actigraphy report between males and females, where males were significantly delayed in bed-timing and get-up timing. Mid-sleep time was also earlier in males than females, but we do not see gender-based differences in sleep efficiency. These results could potentially be used to understand gender-dependent differences in adolescents and may be helpful in forming school policies for adolescents.

INTRODUCTION

The timing and sleep patterns may significantly differ as per age and gender. The association between variations of sleep properties and age and sexual characteristics is essential to be examined in order to recognize the individual sleep patterns or sleep disorders. The study of the influence of age and gender is increasing on general health. Correspondingly, evidence was also increased for sex and gender having differential influences on the consequence of cardiovascular, neurological, and autoimmune diseases, as well as disease sequence and treatment response. Studies have shown that there are sex differences in sleep quality and quantity (van Zundert et al., 2015; Collado et al., 2012; Galland et al., 2017). Compared to males, females are twice as likely to experience sleep disturbances and insomnia throughout their lifespans (Mong et al., 2011). It is suggested that sleep deprivation in females may be related to psychological issues, such as depression and anxiety symptoms, and emotion-focused coping strategies regardless of age (van Zundert et al., 2015). Furthermore, differences can also be associated with caffeine consumption or other substances, since more females drink caffeine after dinner than males (Galland et al., 2017).

The high prevalence of affective disorders or mood disorders in females and other socio-economic disparities have complicated the role of gender in sleep quality (Arber et al., 2009; Goldman-Mellor et al., 2014). The association between sleep and affective disorders or mood disorders is well established, and disturbed sleep is considered one of the main symptoms of clinical anxiety and depressive disorders (Benca et al., 1992). Nevertheless, it is unclear whether the gender difference in sleep quality can be attributed to higher depression rates in females or other socio-economic disadvantages, or whether it is due to the biological difference in the sleep physiology between males and females (Sekine et al., 2006; Lindberg et al., 1997). Along with socio-demographic and affective disorders or mood disorders, lifestyle has also emerged as a significant predictor of sleep problems and poor sleep quality in young adults (Wakasugi et al., 2014). It is seen that physical inactivity, consumption of alcohol, and long computer screen hours are linked to higher odds of sleep problems (Shochat, 2012). However, there is limited knowledge about the differential impact of an unhealthy lifestyle on sleep quality in male and female young adults (Heath et al., 1998).

Sexual characteristic is closely associated with both chronotype and depression. Females are twice as likely to be diagnosed with depression compared to males (Salk et al., 2017). Females experience higher rates of comorbid anxiety, a higher rate of typical features, more somatic and cognitive-affective symptoms, and respond more favorably to selective serotonin reuptake inhibitors than males (Marcus et al., 2008; Schuch, 2014; Young et al., 2009). Sex differences in chronotype have also been reported, and most studies have shown that males are more prone to show the evening chronotype or late chronotype than females (Randler and Engelke, 2019).

In humans, the flexibility in sleep patterns studies is increasing. A study of cross-cultural differences in contemporary infants and toddlers showed a wide range of differences in bed-time, total sleep time, and perception of sleep problems among children (Mindell et al., 2010). To examine sex-dependent variations in sleep/wake patterns, cross-cultural models could be potential. Previous studies suggest the determining factor of sleep could be biological and other related features concerning social and cultural activities. This fluctuation may vary between gender, creating a task to define whether the differences among male's and female's sleep is determined via biological sex or social features.

Regarding sex differences in the circadian phase preference, there are contradictory results that may be related to changes in sexual hormone production (Randler, 2011b). The release of sexual hormones is probably associated with the propensity for eveningness, which can describe the quick progress of chronotype among adolescents. Roenneberg et al., (2007) indicated the peak of eveningness among females is earlier than males, which supports the concept that the circadian regulation of sleep may possibly be caused by sex hormones. However, some psychosocial factors like light exposure, such as screen time at night, are also suggested to have an essential role in the phase delay of adolescents (Carter et al., 2016; Bartel et al., 2015). This pattern appears more significant in females, although it could be related to methodological issues since some female samples present a higher percentage of advanced stages of maturation than males (Carskadon et al., 1993). Nevertheless, some studies have not found any sex differences in sleep complaints and patterns, suggesting a sociocultural influence that can minimize biological sleep regulatory processes (Shochat, 2013).

There is still much to learn about the sex-related framework of adolescent sleep patterns since studies have reported conflicting results when comparing males and females (Sadeh, 2000). Furthermore, it is important to recognize that the need for sleep appears relatively stable across adolescents' development despite all the developmental changes and sex differences (Sadeh et al., 2009). The underlying mechanisms explaining the differences between sexes could be more precise (Zhang et al., 2016; Zhang et al., 2012). However, biological maturation, levels of physical activity, excessive use of electronic equipment, eating habits, and substance consumption may explain the differences (Hysing et al., 2015). There is limited knowledge of the unhealthy lifestyle that influences the changes in sleep quality among males and females in young adults. Therefore, the study aimed to investigate gender differences in sleep patterns among school students.

MATERIALS AND METHODS

Total participants of 900 school students were involved in this study (409 male and 491 female). The participant's age ranged between 14-20 years. A different self-administered questionnaire was applied in the study, such as Morningness-Eveningness Questionnaire (MEQ), to assess a person's chronotype, sleep habits were evaluated by the Pittsburgh's Sleep Quality Index (PSQI), daytime sleepiness was identified by Pediatric Daytime Sleepiness Scale (PDSS) and Epworth Sleepiness Scale (ESS), Cleveland Adolescent Sleepiness Questionnaire (CASQ), was used to examine sleep pattern, and the depression level was measured by Zung Self-Rating Depression Scale (SDS). Armband actigraphy of 456 participants (216 male and 240 female) was used to analyze their sleep/wake patterns.

Statistical analysis

Data are presented as mean ± SE. An unpaired student t-test was used to analyze data. Significance was taken at $P < 0.05$.

RESULTS

Gender-wise comparison of the chronotype percentage was analyzed. The percentage of NT was highest in the population that participated in the study. Among females, 68.1% were NT, 25.7% were MT, and only 6.3% females were ET (Fig. 10). Among male participants, 64.8% were NT, 27.4% were MT, while only 7.8% were identified as ET (Fig. 10).

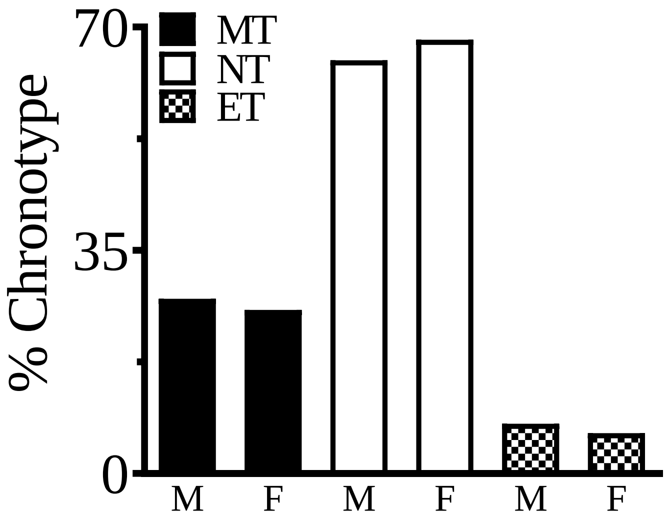

Figure 10: Data is represented as percentage. Percentage of MT, NT and ET of males and females among school students.

Pittsburgh's Sleep Quality Index (PSQI)

The global PSQI score and different sleep habits of PSQI scores were compared between males and females (Fig. 11). Global PSQI score was significantly different (P = 0.032; Unpaired Student t-test; Fig. 11a) between male and female school students. PSQI score was significantly higher in male (6.1±0.1) than female (5.8±0.1; Fig. 11a). When different sleep parameters were studied, significant difference was observed between male and female in get-up time (P = 0.0279; Unpaired Student t-test; Fig. 11c), sleep latency score (P = 0.0123; Unpaired Student t-test; Fig. 11e), and sleep disturbances (P = 0.0332; Unpaired Student t-test; Fig. 11h). Mean get-up time was delayed in male (6.6±0.2; Fig.11c) in comparison to female (6.3±0.0; Fig.11c). Sleep latency score was significantly higher in male (1.2±0.0; Fig.11e) in contrast to female (1.1±0.0; Fig.11e). However, substantially higher score of sleep disturbances was recorded in female than male students (1.5±0.0; Fig.11h). We do not see gender-based differences in bed-time (P = 0.1078; Unpaired t-test; Fig. 11b), sleep quality (P = 0.5844; Unpaired t-test; Fig. 11d), sleep duration (P = 0.9306; Unpaired t-test; Fig. 11f), sleep efficiency (P = 0.0672; Unpaired Student t-test; Fig. 11g), and daytime dysfunction (P = 0.7786; Unpaired t-test; Fig. 11i).

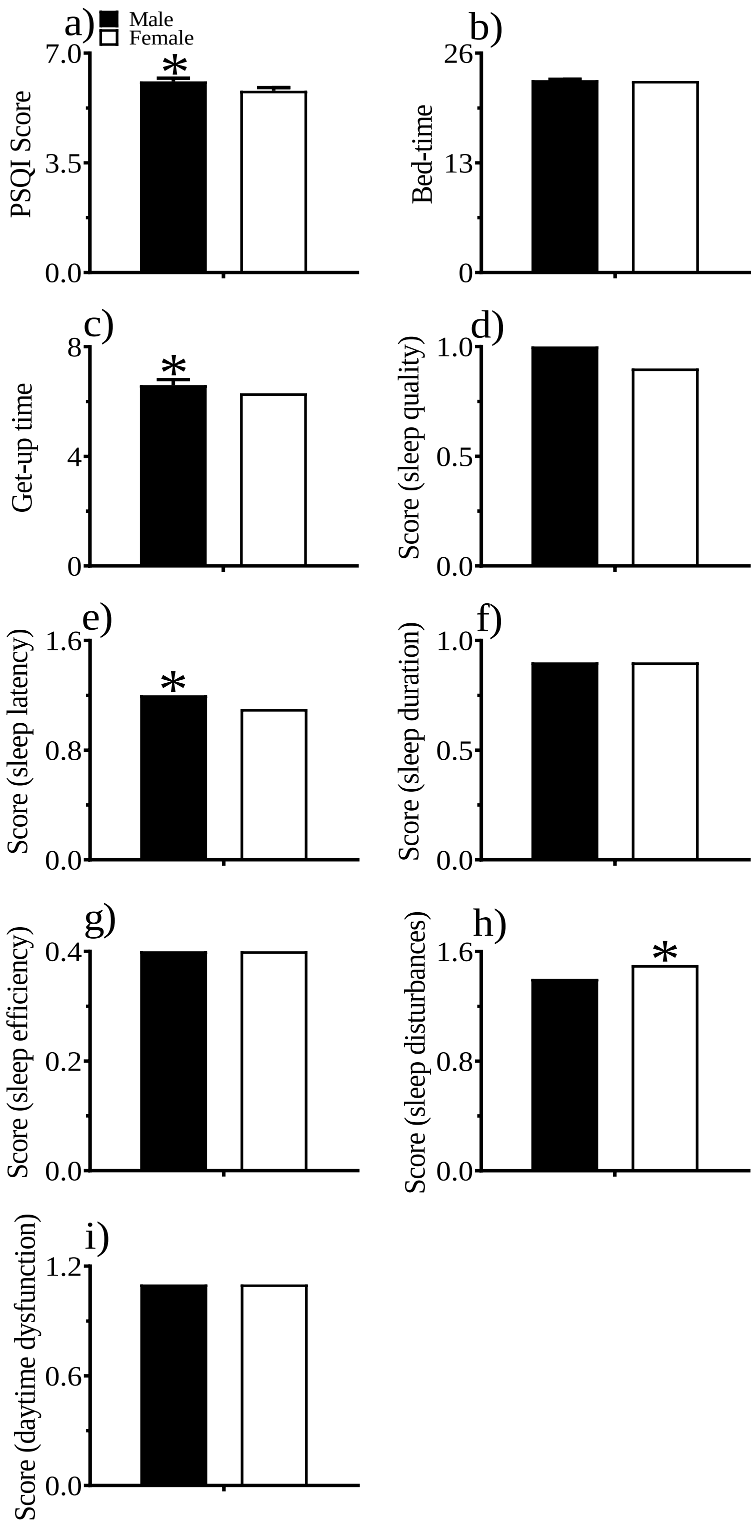

Figure 11: Data is represented as mean ± SE. Comparison of global PSQI score and different sleep habits between males and females. '*' sign indicates significant difference between males and females.

Pediatric Daytime Sleepiness Scale (PDSS)

Figure 12 shows gender-based differences in PDSS scores. PDSS scores significantly differed (P = 0.0300; Unpaired t-test; Fig.12) between males and females. PDSS scores was significantly higher in female (14.7±0.2), than male (14.0±0.2) participants (Fig.12).

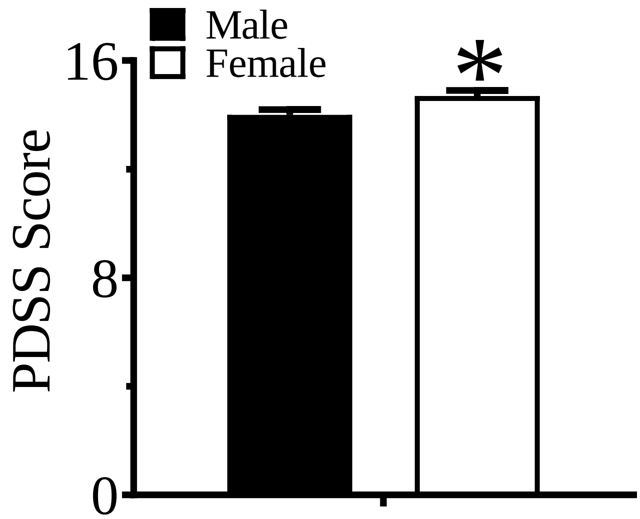

Figure 12: Data is represented as mean ± SE. Comparison of PDSS scores between males and females. '*' sign indicates significant difference between males and females.

Epworth Sleepiness Scale (ESS)

A comparison of ESS scores between males and females is shown in figure 13. We do not see a significant difference ($P = 0.5914$; Unpaired t-test; Fig. 13) in ESS scores between males (7.9±0.2), and females (8.1±0.2).

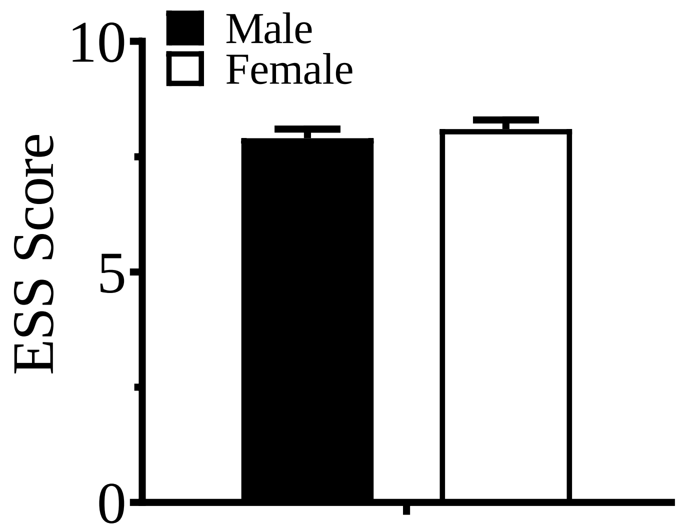

Figure 13: Data is represented as mean ± SE. Comparison of ESS scores between males and females. '*' sign indicates significant difference between males and females.

Cleveland Adolescent Sleepiness Questionnaire (CASQ)

Figure 14 represents a comparison of CASQ scores between males and females. A significant difference was observed between male and female CASQ scores ($P < 0.0001$; Unpaired Student t-test; Fig. 14). CASQ scores was significantly higher in females (42.3±0.3), than males (40.1±0.4).

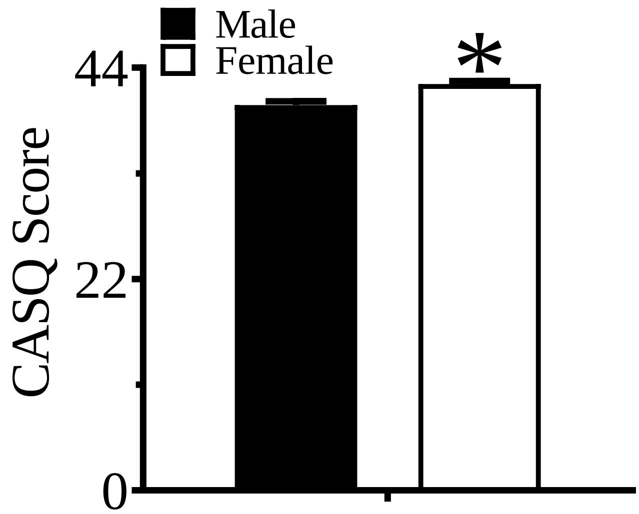

Figure 14: Data is represented as mean ± SE. Comparison of CASQ scores between males and females. '*' sign indicates significant difference between males and females.

Zung Self-Rating Depression Scale (SDS)

A comparison of SDS between males and females is shown in figure 15. Gender-based differences in depression levels were observed between male and female ($P < 0.0001$; Unpaired t-test; Fig. 15) participants. Higher self-rating depression levels was observed among females (44.0±0.3), than males (40.9±0.3).

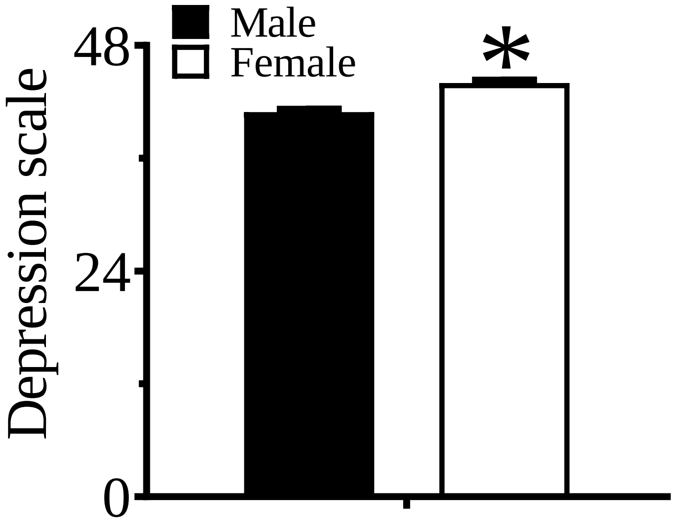

Figure 15: Data is represented as mean ± SE. Comparison of SDS between males and females among school students. '*' sign indicates significant difference between males and females.

Actigraphy

Figure 17 shows a comparison of actigraphy reports between males and females. There was a significant difference between bed-time and get-up time in males and females (Fig. 17a,b). Significant delays in bed-time and get-up time were observed among males (bed-time: P = 0.0145; Unpaired t-test; Fig. 17a; get-up time: P = 0.0050; Unpaired t-test; Fig. 17b).

Gender-wise analysis suggests that there is a significant difference in time in bed (P = 0.0249; Unpaired t-test; Fig. 17c), sleep onset latency (P = 0.0314; Unpaired t-test; Fig. 17e), wake after sleep onset (P = 0.0110; Unpaired t-test; Fig. 17g), and mid-sleep time (P = 0.0105; Unpaired t-test; Fig. 17h). Time in bed was significantly longer for female (9.8±0.2) than male (8.8±0.3; Fig. 17c), longer sleep onset latency was observed in male (14.5±0.3) than female (13.3±0.5; Fig. 17e). Wake after sleep onset was significantly longer in female (57.9±4.4) than male (43.3±3.6; Fig17g), mid-sleep timing was also delayed in female (4.1±0.2) than male (3.5±0.1; Fig. 17h). No significant difference was observed in total sleep time (P = 0.1262; Unpaired t-test; Fig. 17d), and sleep efficiency (P = 0.4738; Unpaired t-test; Fig. 17f).

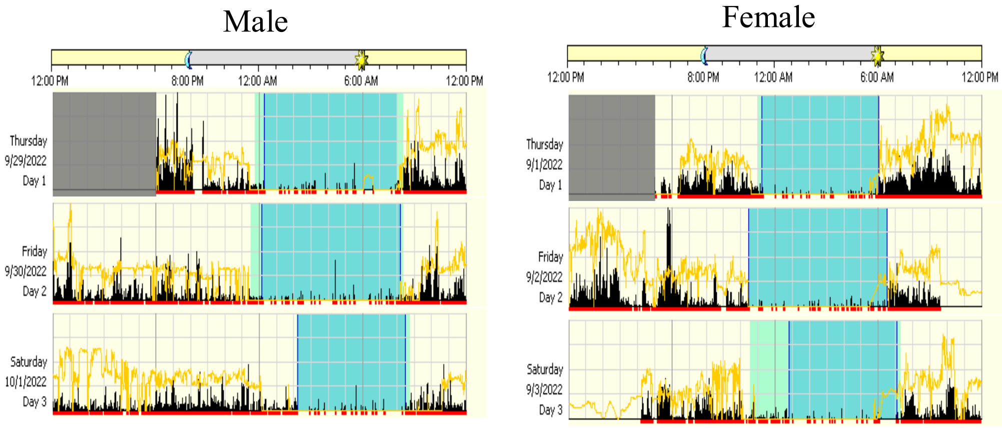

Figure 16: Representative actogram of male and female

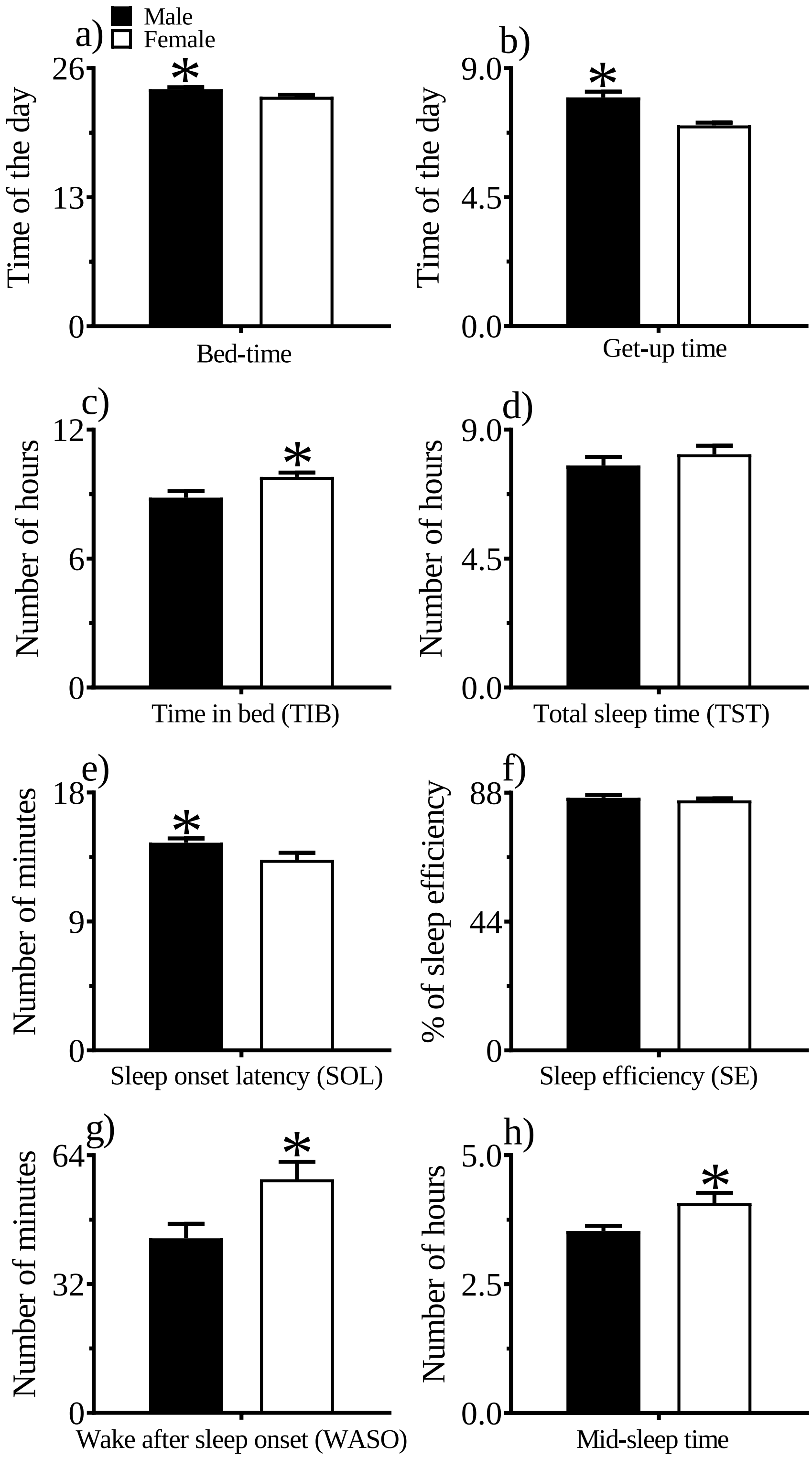

Figure 17: Data is represented as mean ± SE. Comparison of actigraphy report between males and females. '*' sign indicates significant difference between males and females.

DISCUSSION

Irrespective of gender, the NT population dominated both male and female school participants (Fig. 10). 68.1% female and 64.8% male participants were identified as NT (Fig. 10). As a general trend we have seen in Mizo students (section 1), MT participants were dominating over ET both male and female participants (Fig. 10). The differences of person's morningness-eveningness are linked with the intrinsic biological rhythm of an individual. Evening and morning person varies in their genetics, and about 37.0% of the variance in morningness-eveningness can be explained by genetic influence (Watson et al., 2013). A nationwide study evaluating chronotype among the American population showed that males were more prone to have late chronotype than females (Fischer et al., 2017). A meta-analysis study also suggests that in comparison to females, males are more evening-oriented (Randler and Engelke, 2019). This trend has also been observed in our study on school students, as late chronotype was more prevalent in males (7.8%; Fig. 10) than females (6.3%; Fig. 10). Our results from student participants are similar to the findings of the study conducted on Korean population. In a cross-sectional survey conducted on the population of Korea, the prevalence of late chronotype was higher in males (16.9%) than in females (14.0%; Kim et al., 2020). Similarly, with the Korean population, our study observed the frequency of NT was lower in males (64.8%) than in female participants (68.1%). Sex-dependent differences in chronotype could be because of the variation in the part of melatonin. In diurnal vertebrates, melatonin is a sleep-promoting hormone and is a key component of the circadian organization, including chronotype (Kantermann et al., 2015; Santhi et al., 2016).

Further, sex hormones can also be a potential key player in sex-dependent chronotype differences. Studies among adolescents revealed that higher testosterone levels are related to higher eveningness (Hagenauer and Lee, 2012); while in comparison to intermediate chronotype, women with morning chronotype show earlier increases in oestradiol levels during their menstrual cycles (Michels et al., 2020). In addition, differences between morning and evening people are found in their daily fluctuation of core body temperature (Baehr et al., 2000), their peak melatonin secretion (Burgess and Fogg, 2008), as well as in their cortisol awakening levels (Randler and Schaal, 2010). Furthermore, male university students with ET chronotype showed higher testosterone levels (Randler et al., 2012). Therefore, morningness-eveningness backs up an individual characteristic by biological developments. The relation with gender to physiological and cultural aspects is investigated by some previous studies, where females frequently do household work that can be linked with morning chronotype. In the current study, a higher percentage of MT than ET was observed (Fig. 10). It could be because of the age group involved in the study, as these subjects were school students who are generally not involved in many household activities; therefore, there was no specific gender (female) dependent responsibilities at home. However, the studies also suggest that the gender-based differences in chronotype diminish with time (Randler and Engelke, 2019).

We have observed gender-based differences in different sleep quality parameters accessed using different questionnaires (Fig. 11-14). Altogether, our finding suggests that poor sleep quality was higher among female than male participants (Fig. 11-14). Similar results have been reported for the Australian population (Fatima et al., 2016). When the PSQI scores was compared between males and females, the global PSQI score was higher among males showing that poor sleep quality was observed in males than females (Fig. 11). The perception of sleep quality being a subjective issue is found to be affected by cultural and social practices and racial background (Song et al., 2011). Gender difference in poor sleep quality has been previously reported for older populations (Luo et al., 2013), but evidence from some recent studies also found gender difference to be present in sleep quality in young adults (Hung et al., 2013). However, existing studies do not provide information on whether gender difference remains significant after concurrently considering the impact of other socio-demographic, lifestyle factors, and affective disorders (Lindberg et al., 1997). The gender difference in sleep problems is mainly attributed to the primacy of affective disorders and socio-economic disparities, suggesting these may be the pathway variables through which gender disparity in poor sleep is exhibited (Bruck and Astbury, 2012; Arber et al., 2009; Sekine et al., 2006). Sleep patterns measured by PDSS, CASQ, and depression levels assessed by SDS were compared on a gender-basis, and higher scores were observed among females (Fig. 12,14,15). Gender and Regional Differences in Sleep Quality have also been reported among the population of China, and female tended to have a poorer sleep quality and a higher prevalence of insomnia in rural than urban residents (Tang et al., 2017).

Our study shows higher self-rating depression levels among female than male participants (Fig. 15). Previous studies suggest that adolescence is a high-risk phase for depression, especially for females (Rohde et al., 2009). This higher depression level in female participants has also been found among Korean high-school students (Koo et al., 2020). Studies suggest that females are more likely to be depressed than males, both in terms of unipolar depressive episodes and in terms of depressive symptoms (Kessler, 2003; Nolen-Hoeksema, 2001). The rate of major depression can rise from 5.0% during early adolescence up to 20.0% by the end of adolescence (Hankin et al., 1998). A study with American youth (age group 11-17 years) reveals that adolescents with sleep disturbances have a higher level of depression (Roberts and Duong, 2014). An increase in the gender difference in depression with age is also observed (Mirowsky, 1996). Sleep debt and poor sleep quality lead to unfavorable health conditions and consequences (Medic et al., 2017). Differential actigraphy report was observed on the gender basis (Fig. 17). The bed-timing and get-up time were delayed among males (Fig. 17a,b), and the percentage of time spent in bed for sleeping was higher in males (Fig. 17e). However, females spent more time between bed-time and get-up time (Fig. 17c) and higher number of waking minutes during sleeping and mid-sleep time was observed among female (Fig. 17g,h). Among children and adolescents, further investigation is required about sex variations in the sleep quality as well as its associated health outcome, affecting the sleep patterns all through the lifetime. A study from the Brazilian population trends that evening typology is associated with a higher risk of reporting depression (Hildago et al., 2002).

In conclusion, our findings suggest gender-dependent sleep quality and depression levels among adolescents, and it may be significant not only to witness post-pubertal adolescence for depressive conditions but furthermore to investigate sleep timing and activity patterns. These studies suggest the need to deliver different services or platforms for individuals with sleep complaints.

SECTION 3. TO STUDY THE PERSISTENCE OF SOCIAL JETLAG

ABSTRACT

Adolescence is an important stage with reference to variations in sleep properties. Social jetlag is referred to as the changes in sleep/wake timing between weekdays and weekends. Among adolescents, the prevalence of sleep disturbances is increasing and then related to poor functioning, and it is a significant concern among school students. Thus, the increase in the prevalence of sleep problems is now considered a global public health problem. Social jetlag affects almost all life stages; it is more prominent among young adults. Chronotype and social jetlag may affect sleep disorders, temperament, mood disorders (specifically depression), well-being, menstrual cycles, usage of stimulating substances, and increased body mass index. Therefore, the present study is designed to examine sleep patterns during weekdays and weekends. Altogether sleep/wake patterns of 456 school students (216 male and 240 female participants) were recorded using armband actigraphy for four consecutive days i.e., from Thursday to Sunday. Their chronotype was measured using Morningness-Eveningness Questionnaire (MEQ). Various sleep properties of actigraphy reports were analyzed. Our results suggest that there are differences in bed-time, get-up time, and total sleep time during weekdays and weekends. These properties are independent of gender. Further, NT participants showed longer sleep time during weekends.

INTRODUCTION

The effect of chronotype on well-being could be the outcome of the misalignment between the internal circadian clock (chronotype) and social schedule (e.g., school/work schedule; Wittmann et al., 2006). This mismatch is stated as 'social jetlag.' If a person shifts their sleep schedule due to environmental demand (e.g., a MT person delays their sleep time to meet the demand of the shift-work or late evening office work), their sleep may get affected. As a result, subsequent daytime functioning may be impaired, and compensatory approaches, such as consumption of caffeine or other stimulant or excessive use of cigarettes, may be implemented, which may result in further worsening of their subsequent night-time sleep, setting off a vicious phase of their well-being. Due to globalization and the excessive use of electronic media, the probability of social jetlag is increasing among adolescents and young people. The negative effect on sleep (both delayed and shortened) because of untimely electronic media use among adolescents and young people is alarming (Cain and Gradisar, 2010).

Adolescents experience a shift toward later chronotype, or preferred later timing of daily activities (e.g., sleep), compared to children and adults (Borisenkov et al., 2012; Carskadon et al., 1993; Randler et al., 2017; Roenneberg et al., 2004). Proportional to total sleep time on the weekends, late chronotype individuals have a tendency to short total sleep time during the school days, that result in late bed timing; however, they secure early get-up time because of school and other responsibilities. As a result, later chronotype tends to accumulate sleep debt during the school week and must compensate with longer total sleep time on the weekends when they are 'free' to wake-up late (Roenneberg et al., 2003; Roepke and Duffy, 2010; Vitale et al., 2015). Later chronotypes thus tend to have a sleep interval with a later mid-point on the weekends relative to the school week (Wittmann et al., 2006). Adolescents experience more social jetlag compared to adults (Wittmann et al., 2006; Touitou, 2013) due to the shift toward a later chronotype during adolescence (Borisenkov et al., 2012; Carskadon et al., 1993; Randler et al., 2017; Roenneberg et al., 2004) and early school start timing (Vollmer et al., 2016; Wheaton et al., 2015). Social jetlag is associated with negative mood states, such as depressive symptoms

(Levandovski et al., 2011; Polugrudov et al., 2016) and lower psychological well-being among adults. Minimum total sleep time is related to more social jetlag. Adolescents having evening chronotype with a preference for delayed bed-timing and get-up time are mainly interfered with by social demands. Maximum changes between weekdays and weekends sleep patterns are reported for ET, causing weekdays to sleep debt and leading to compensated sleep at weekends. Social jetlag has been identified as a risk factor for psychological disorders (Levandovski et al., 2011) and obesity (Roenneberg et al., 2012; Challet, 2013). The influence of age-related sleep delay is particularly important in adolescents when the impact of restricted school-night sleep increased, and is being recognized as a public health problem (Gradisar et al., 2011; Touitou, 2013). A related occurrence may happen in adulthood during efforts to improve sleep debt by oversleeping on weekdays or working days during the weekends or holidays. In children and adolescents, weekends and weekdays sleep schedules differ due to school attendance (Carskadon et al., 2004); thus, the time at which classes begin may contribute to sleep deprivation in this population (Hansen et al., 2005).

The problem of pervasive and chronically inadequate sleep among adolescents is increasingly recognized as a public health issue (Colten and Altevogt, 2006; Gradisar et al., 2011; Owens, 2014). Among adolescents, social, psychological, and biological differences have reflective results on the timing of sleep and sleep duration and have consequences for well-being and health. During adolescence, there is a shift in biological preference to later sleep timing, which often conflicts with socially prescribed scheduling demands, such as early school start time (Carskadon et al., 2004). On unscheduled days, change in sleep timing occurs due to the involvement of biological efforts that are ideal for the sleep epoch while struggles with lifestyle or environmental burdens happen. Then, a sub-optimal sleep epoch can result due to these conflicts on scheduled days. Social jetlag has been posited as an explanation for the associations of late chronotype with tobacco and alcohol use (Wittmann et al., 2006), and academic performance (Haraszti et al., 2014). Social jetlag tends to be most pronounced in the evening chronotype, whose preference for later bed- and wake-time conflicts with environmentally determined sleep schedules or lifestyle choices (Wittmann et al., 2006). Circadian systems are slow to adapt to the rapid changes in the sleep/wake cycle, which is common during adolescence, making social jetlag particularly interesting in this age group (Dahl and Lewin, 2002). Previous studies show that about 40.0-68.0% of high school students have a high social jetlag of two hours or longer, and individuals with an evening chronotype usually have a larger social jetlag (Malone et al., 2016). As high school students are subjected to more severe and adverse influences of social jetlag, because the evening chronotype is highest in the late teens (Roenneberg et al., 2019), it can be a possible predictor of academic stress.

Adolescents experience short sleep during the school week and more social jetlag compared to adults (Touitou, 2013; Wittmann et al., 2006) due to the combination of both shift towards later chronotype during adolescence (Borisenkov et al., 2012; Carskadon et al., 1993; Randler et al., 2017; Roenneberg et al., 2004) and early school start time (Vollmer et al., 2016; Wheaton et al., 2015). Thus, both short total sleep time during weekdays and social jetlag is widespread among adolescents. Often the constraints on scheduled days are thought of in terms of structural demands, such as school or work start time (Haraszti et al., 2014; Díaz-Morales et al., 2015), but in adolescence, increased academic and social engagement, as well as lifestyle choices, are likely to contribute to increased social jetlag (Dahl and Lewin, 2002). We do not have much understanding of the influence of social schedules on sleep properties among Indian school students, and hence, this study was performed. The goal of this study was to identify the difference between sleep patterns during weekdays and weekends.

MATERIALS AND METHODS

The sleep/wake patterns of 456 school students (216 male and 240 female participants) were assessed in the study. Their chronotype was evaluated using Morningness-Eveningness Questionnaire (MEQ) developed by Horne and Ostberg, (1976). The sleep/wake patterns were measured using armband actigraphy for four consecutive days, i.e., from Thursday to Sunday. Average night-time sleep measures such as:- bed-time, get-up time, time in bed (TIB), total sleep time (TST), sleep onset latency (SOL), sleep efficiency (SE), wake after sleep onset (WASO), and mid-sleep time for weekdays or working days and weekends or free days were calculated.

Statistical analysis

Data are presented as mean ± SE. Paired student t-test was used to analyze the data. Significance was taken at $P < 0.05$.

RESULTS

Figure 19 represents the different sleep parameters accessed by actigraphy during weekdays and weekends. A significant difference in bed-time ($P = 0.0245$; Paired t-test; Fig. 19a), get-up time ($P < 0.0001$; Paired t-test; Fig. 19b), time in bed ($P = 0.0371$; Paired t-test; Fig. 19c), total sleep time ($P = 0.0073$; Paired t-test; Fig. 19d), and sleep onset latency ($P = 0.0253$; Paired t-test; Fig. 19e) was observed between weekdays and weekends (Fig.19). There was a significant delay in bed-time, get-up time, time in bed, total sleep time and sleep onset latency during weekends than weekdays (Fig.19). No significant difference in sleep efficiency ($P = 0.8584$; Paired t-test; Fig. 19f), wake after sleep onset ($P = 0.1774$; Paired t-test; Fig. 19g), and mid-sleep time ($P = 0.9995$; Paired t-test; Fig. 19h) was observed.

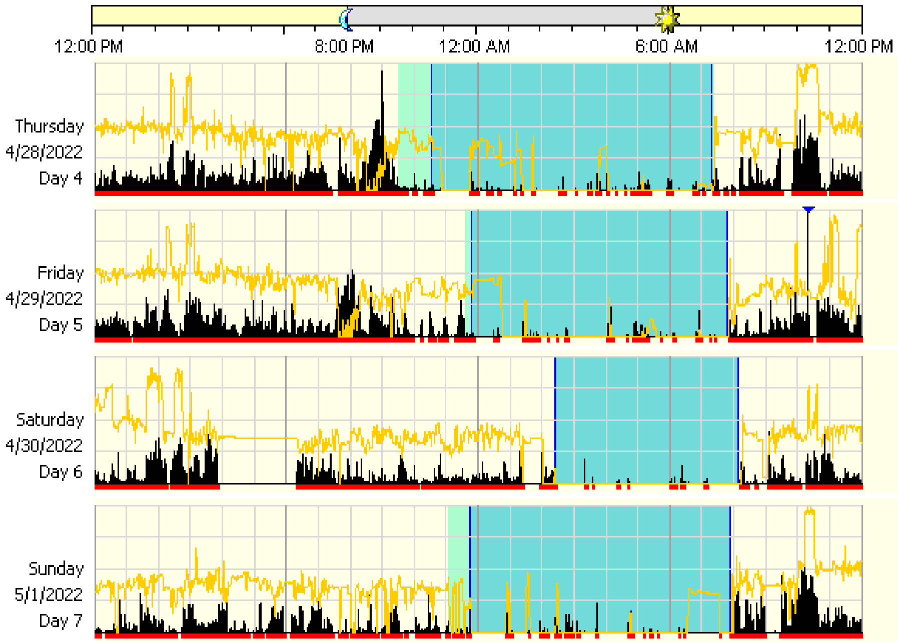

Figure 18: Representative actogram of weekdays and weekends

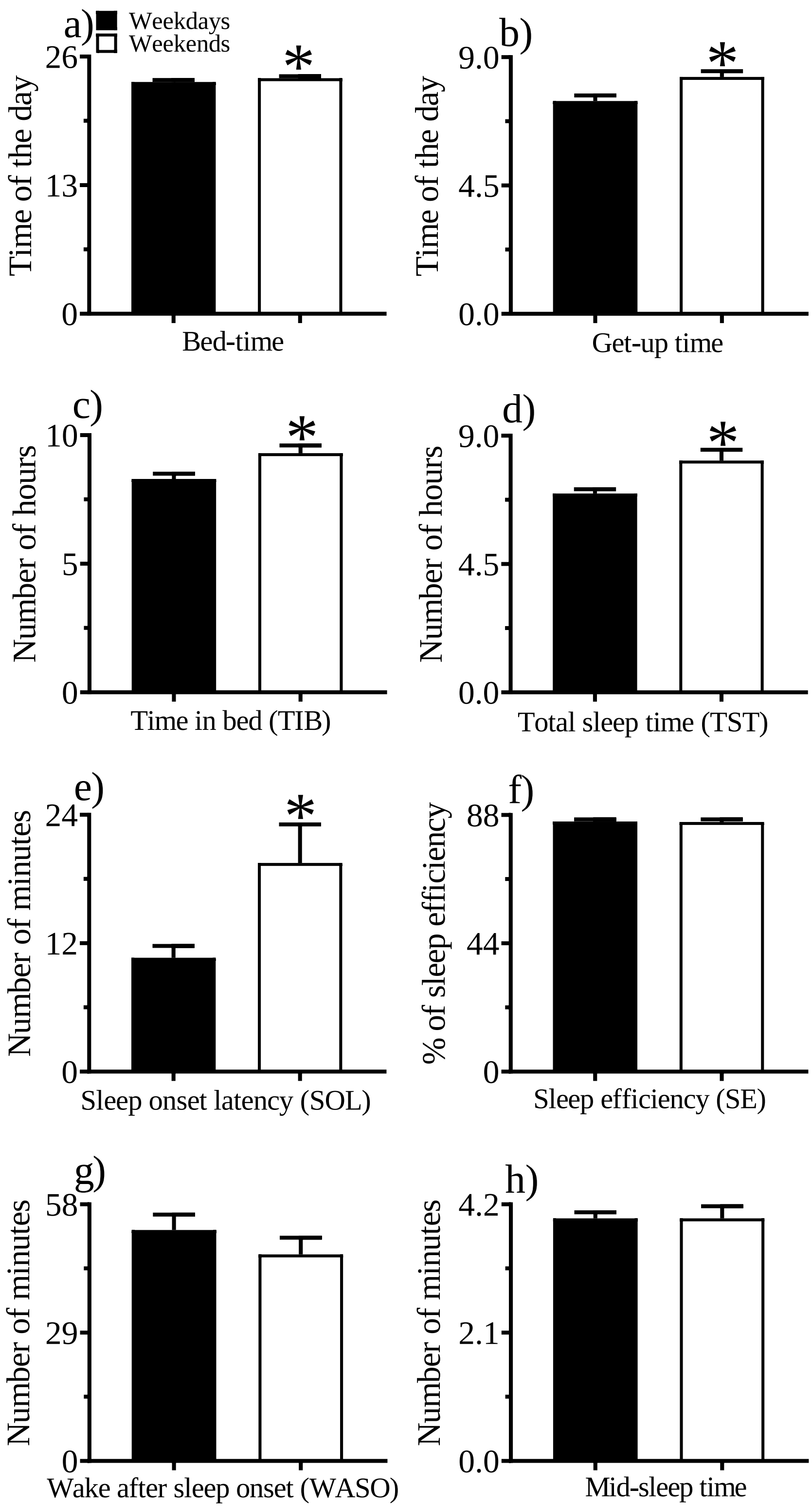

Figure 19: Data is represented as mean ± SE. Comparison of actigraphy report between weekdays and weekends. '*' sign indicates significant difference between weekdays and weekends.

Gender-wise analysis of sleep parameters among males suggests that among male participants, bed-time (P = 0.0250; Paired t-test; Fig. 20a), get-up time (P = 0.0010; Paired t-test; Fig. 20b), time in bed (P = 0.0399; Paired t-test; Fig. 20c), and total sleep time (P = 0.0086; Paired t-test; Fig. 20d) was significantly different during weekends than weekdays (Fig. 20). Both bed-time and get-up time as well as time in bed and total sleep time was delayed during weekends (Fig. 20a,b,c,d). There was no significant difference in sleep onset latency (P = 0.5839; Paired t-test; Fig. 20e), sleep efficiency (P = 0.2172; Paired t-test; Fig. 20f) wake after sleep onset (P = 0.3879; Paired t-test; Fig. 20g), and mid-sleep time (P = 0.7533; Paired t-test; Fig. 20h).

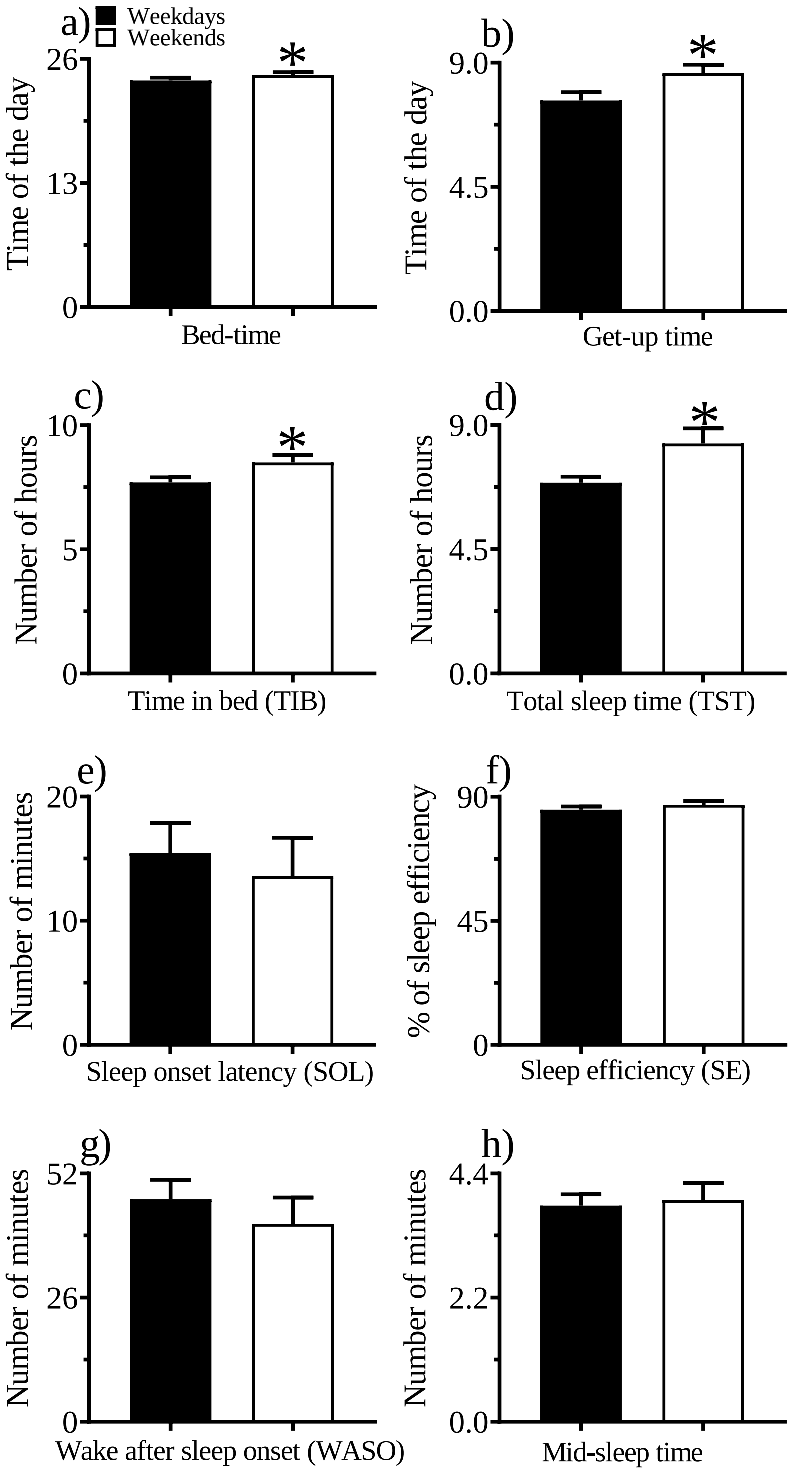

Figure 20: Data is represented as mean ± SE. Comparison of male actigraphy report between weekdays and weekends. '*' sign indicates significant difference between weekdays and weekends.

Figure 21 represents the different parameters of the actigraphy report during weekdays and weekends of female participants. A significant difference was found in get-up time ($P = 0.0223$; Paired t-test; Fig. 21b), time in bed ($P = 0.0464$; Paired t-test; Fig. 21c), total sleep time ($P = 0.0214$; Paired t-test; Fig. 21d), and sleep onset latency ($P = 0.0250$; Paired t-test; Fig. 21e) during weekdays and weekends. Get-up time, time in bed, and total sleep time were delayed during weekends, and sleep onset latency was significantly longer during weekends (Fig. 21). No difference in bed-time ($P = 0.5109$; Paired t-test; Fig. 21a), sleep efficiency ($P = 0.0711$; Paired t-test; Fig. 21f), wake after sleep onset ($P = 0.2823$; Paired t-test; Fig. 21g), and mid-sleep time ($P = 0.6661$; Paired t-test; Fig. 21h) was observed.

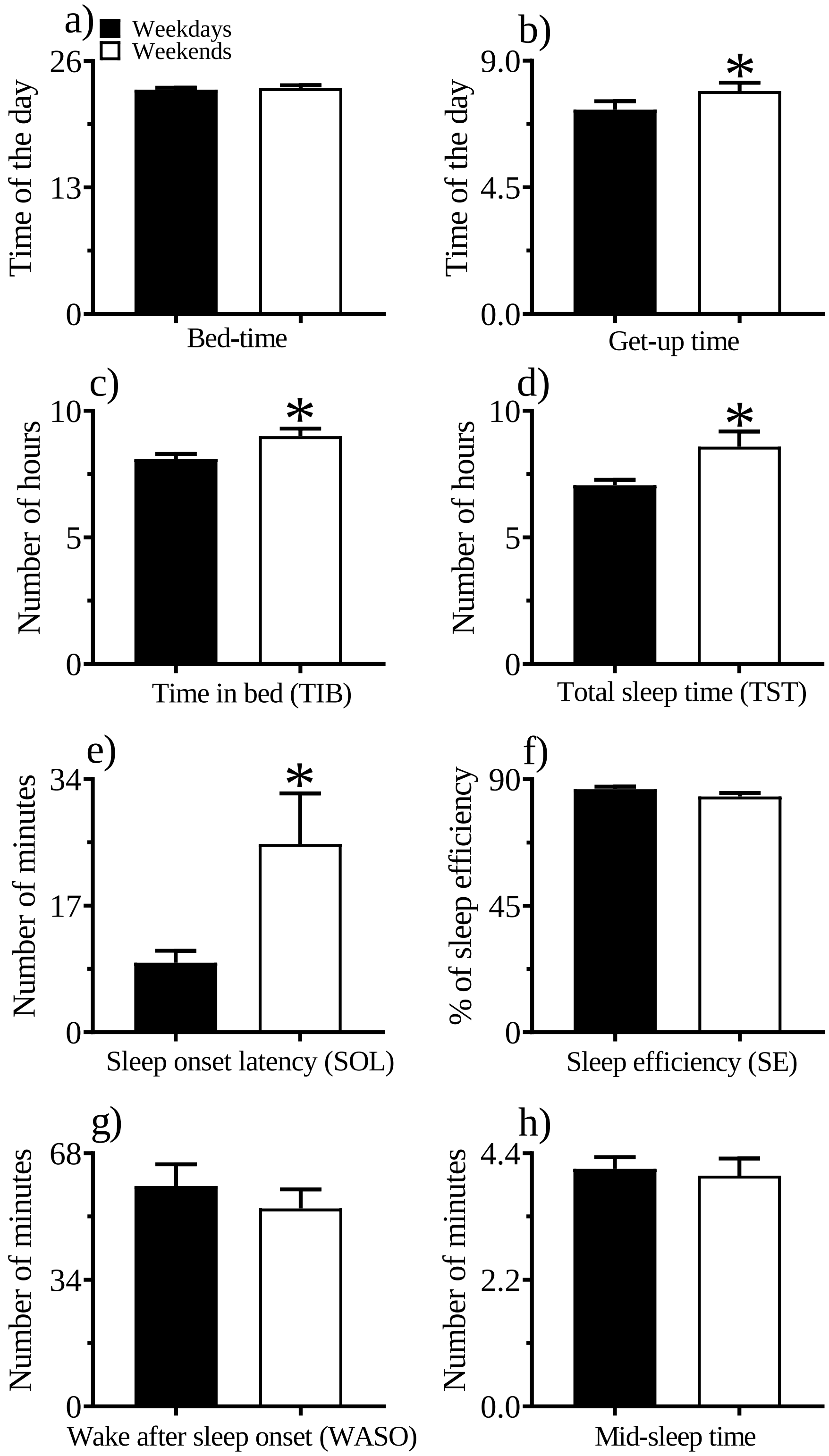

Figure 21: Data is represented as mean ± SE. Comparison of females actigraphy report between weekdays and weekends. '*' sign indicates significant difference between weekdays and weekends.

We analyzed the data of actigraphy based on chronotype (Fig. 22). Among MT, a significant difference between weekdays and weekends was observed only in wake after sleep onset (P = 0.0130; Paired t-test; Fig. 22s), which was significantly delayed during weekends (Fig. 22s). However, there was no difference in the bed-time (P = 0.7196; Paired t-test; Fig. 22a), get-up time (P = 0.4212; Paired t-test; Fig. 22d), time in bed (P = 0.5491; Paired t-test; Fig. 22g), total sleep time (P = 0.5588; Paired t-test; Fig. 22j), sleep onset latency (P = 0.1277; Paired t-test; Fig. 22m), sleep efficiency (P = 0.7715; Paired t-test; Fig. 22p), and mid-sleep time (P = 0.5645; Paired t-test; Fig. 22v) between weekdays and weekends. Among NT, a significant difference was found in bed-time (P = 0.0495; Paired t-test; Fig. 22b), get-up time (P = 0.0002; Paired t-test; Fig. 22e), time in bed (P = 0.0481; Paired t-test; Fig. 22h), and total sleep time (P = 0.0395; Paired t-test; Fig. 22k) which were delayed during weekends (Fig. 22b,e,h,k). No difference in sleep onset latency (P = 0.1810; Paired t-test; Fig. 22n), sleep efficiency (P = 0.6134; Paired t-test; Fig. 22q), wake after sleep onset (P = 0.4734; Paired t-test; Fig. 22t), and mid-sleep time (P = 0.8020; Paired t-test; Fig. 22w) was observed. There was no difference in all parameters among ET: bed-time (P = 0.1860; Paired t-test; Fig. 22c), get-up time (P = 0.2792; Paired t-test; Fig. 22f), time in bed (P = 0.7274; Paired t-test; Fig. 22i), total sleep time (P = 0.7008; Paired t-test; Fig. 22l), sleep onset latency (P = 0.4731; Paired t-test; Fig. 22o), sleep efficiency (P = 0.8454; Paired t-test; Fig. 22r), wake after sleep onset (P = 0.6310; Paired t-test; Fig. 22u), and mid-sleep time (P = 0.6990; Paired t-test; Fig. 22x).

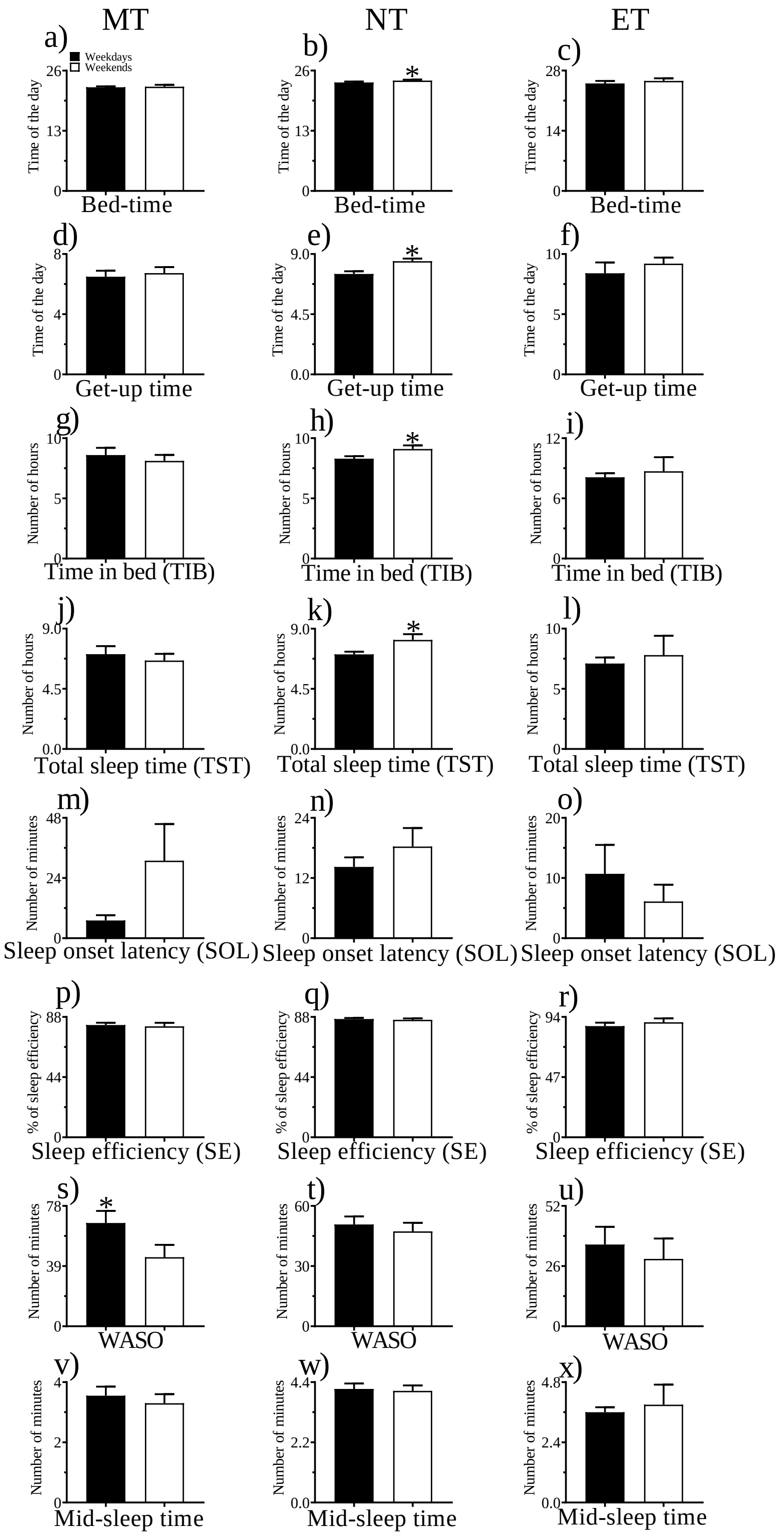

Figure 22: Data is represented as mean ± SE. Comparison of actigraphy report between weekdays and weekends of MT, NT and ET. '*' sign indicates significant difference between weekdays and weekends.

DISCUSSION

Among adolescents, the presence of sleep difficulties is increasing. A significant number (68.9%) of high school students in the US reported insufficient sleep (≤ 7 hours on a school night; Eaton et al., 2010), 62.6% of adolescents (age group ranging from 13-19 years) in Singapore reported short sleep duration (< 7 hours on a school night; Yeo et al., 2019) while in Japanese adolescents (15-18 years) average sleep less than 7 hours has been reported (Morishima et al., 2020; Tagaya et al., 2004). Many adolescents had short sleep duration suggested by these results. Our study indicates that overall participants were sleeping more than 7 hours both during weekdays (7.0±0.2 hours), and weekends (8.1±0.4 hours). Our study also shows an overall significant difference in sleep duration between weekdays and weekends (Fig. 19d). Previous study shows that adolescents go to bed earlier on weekdays than on weekends, with a total night-time sleep of 7.84 hours and 8.65 hours on weekdays and weekends respectively. Ideally, adolescents require 9 hours of sleep, children need more than 10 hours, and adults need 8 hours. Among adolescents, one of the causes for short sleep duration during weekdays may be probably because of early school start time, incapability of sleeping at night-time, physical behavior, and active social life as well as schoolwork. These shortened sleeping hours were also observed among Turkish adolescents that have a sleeping time of 7.00 hours and 8.00 hours on weekdays and weekends, respectively (Kutluhan et al., 2011). The young people have many events, even on weekdays, greatly social weekend's programs, and widespread religious activities. The sleeping schedule among adolescents is influenced by all of these factors. It has also been observed in other studies that adults go to bed- and get-up earlier during the week than on the weekends due to the influence of social commitments (Monk et al., 2000; Rosenthal et al., 2001; Wittmann et al., 2006).

Our study gender-wise analysis suggests that both male and female participants were sleeping significantly longer on weekends (Fig. 20,21). Male participants slept around 1.4 hours longer during weekends, while female participants slept around 1.5 hours longer. Together we do not see differences in sleep timing on weekdays and weekends on a gender basis. Further, the chronotype-based analysis proposed that there are no differences in average sleep time between weekdays (7.09±0.6 hours) and weekends (6.61±0.5 hours) among MT and ET (weekdays = 7.1±0.5 hours, weekends = 7.8±1.6 hours). However, NT participants slept longer during weekends (8.2±0.4 hours) than on weekdays (7.1±0.2 hours). Most of the studies show more severe effects of early school start timing on evening chronotype, who have to reduce the duration of sleep, compensating weekdays by oversleeping at the weekends. A recent study on adolescent male basketball players shows the impact of chronotype and day of the week on sports performance (Bruno et al., 2023). Individuals' adjustment of sleep requirements between biological timing and social constraints is influenced by the endogenous (circadian) clock embedded into the environmental light-dark cycle (Adan et al., 2012). Evening chronotype and longer social jetlag are considered circadian rhythm indicators (Borisenkov et al., 2015). Previous studies report females show a delayed bed-time on the weekends and may also ruminate near bed-time and, therefore, have more social jetlag than males. These manners among females may result in immediately delayed in the bed-timing, social jetlag, and also relatively affecting depression disorder. The bed-timing sex differences may be described by the habits of online social media alterations. Female adolescents are more likely to make technology-based social comparisons than males, and the association between technology-based social comparisons and depressive symptoms is stronger in females than males (Nesi and Prinstein, 2015). Indeed, having an electronic device (such as a mobile phone) in the bedroom or used of internet before bed-time predicts greater social jetlag, and these behaviors are more prevalent in female adolescents (Nesi and Prinstein, 2015; Spilková et al., 2017). During weekends or workdays in comparison to weekdays, females are more probable used social media and are delayed in the bed-timing. Consequently, social jetlag increases the risk of depression among female adolescents. The consequences of social jetlag vary between male and female adolescents needs to be investigated by the upcoming experimental studies.

Social jetlag has been associated with symptoms of depression, as well as risk factors for metabolic syndrome, obesity, and cardiovascular disease (Valdez et al., 1996; Scheer et al., 2009; Levandovski et al., 2011; Roenneberg et al., 2012; Kantermann et al., 2013; Rutters et al., 2014; Wong et al., 2015). Therefore, considering the changing aspects of social jetlag as well as its impact is essential in order to increase the development of disease inhibition approaches aiming at social jetlag or disorder of sleep/wake timing. Social jetlag was more common in individuals of evening chronotype and subsequently related to students; social jetlag was higher among those who were employed. These observations agree with the concept that social jetlag results from misalignment between an individual's social and biological timing (Wittmann et al., 2006), and with previous observations that adults with later chronotype had greater social jetlag (Valdez et al., 1996; Levandovski et al., 2011; Roenneberg et al., 2012; Rutters et al., 2014; Parsons et al., 2015). The finding that "eveningness" was associated with disrupted sleep is similar with previous studies (Giannotti et al., 2002; Merikanto et al., 2012; Merikanto et al., 2015). Evening chronotype tends to have a shorter sleep on weeknights, delayed bed and wake-time on the weekends, insomnia, and report poor quality or insufficient sleep relative to morning chronotype (Wolfson and Carskadon, 1998; Koskenvuo et al., 2007; Merikanto et al., 2012). Eveningness also has been associated with increased substance use, alcohol consumption, and smoking (Koskenvuo et al., 2007; Broms et al., 2011; Merikanto et al., 2017). Earlier studies reported a significant association between mortality and weekdays and weekends sleep. Short sleep duration during weekdays had a higher mortality rate if there was no compensation for more sleep on the weekends (Akerstedt et al., 2019).

One of the known factors affecting academic pressure was social jetlag. According to earlier studies, social jetlag has a negative outcome on total night-time sleep during weekdays (McMahon et al., 2018) and on school performance, greater than 40.0% of high school students nap in school because of night-time sleep deficiency caused by social jetlag (Malone et al., 2016). This may be significant to the finding that academic success and cognitive abilities decline with increasing social jetlag (Díaz-Morales and Escribano, 2015), thereby leading to poorer scores in morning exams (Haraszti et al., 2014). In addition, watching TV in bed or time spent using a computer and cell phone before sleeping was found to increase social jetlag among high school students (Uslu et al., 2021). Decreasing blue light exposure in the evening advanced melatonin secretion and, thus, promoted faster sleep onset, which in turn reduced social jetlag (Zerbini et al., 2017). Hence, it is essential to increase awareness to reduce social jetlag about its adverse effects and inform about sleep hygiene to school students. This includes, for example, structuring a regular sleep/wake schedule, increasing light exposure in the mornings, and reducing blue light exposure in the evenings (Arns et al., 2021). Though social jetlag is often not studied among adolescents, it is also important to remember that social jetlag is something that affects most people at some point in their life, although adolescents are at relatively more risk (Wittmann et al., 2006).

SECTION 4. TO STUDY SEASONAL SLEEP VARIATIONS

ABSTRACT

Humans need sleep to recover and restore their bodies and brains, and impaired physical and mental functioning is related to sleep deficiency. The term "seasonality" describes the seasonal fluctuations of several environmental parameters, including photoperiod (day duration), light intensity, ambient temperature, and food availability. The relationship of recognizable seasonal variations with sunlight, like the midnight sun in summer and during midwinter, the quality of sleep, or the occurrence of sleeplessness of seasonal differences is well investigated. Hence, the present study aimed to investigate sleep variations across seasons. Participants (456 school students having 216 males and 240 females) were asked to fill out the Horne and Ostberg Morningness-Eveningness Questionnaire (MEQ) for the measurement of chronotype, and their sleep/wake patterns were recorded using actigraphy. The study was conducted over four months, i.e., March, June, September, and December. Differentiation actigraphy reports were observed across the season when actigraphy data were compared between the four months. Our results suggest that get-up time, time in bed, and total sleep time vary annually. Further, these differences in sleep properties are dependent on sex and time of the year. The chronotype-dependent analysis also confirms the effect of chronotype on various sleep parameters.

INTRODUCTION

Seasonal variations in physiology and behavior have been observed since a long time ago (Wehr, 1998). In particular, seasonal variations in mood and sleep have been demonstrated by numerous studies. However, seasonality effect on sleep and sleep deficiency are not yet fully understood scientifically, despite the possibility that it could aid in developing the ideal sleep hygiene platform in order to lessen sleep disorders like insomnia or hypersomnia. Most research on seasonal variations in sleep duration has focused on seasonal affective disorder (SAD), a kind of sadness with a seasonal rhythm that often manifests in the autumn and winter and remits in the spring or summer (Rosenthal et al., 1984).

Seasonal sleep fluctuations between the midnight sun and the dark period have been investigated primarily in Northern European nations. According to epidemiological research in these nations, there is a seasonal influence on sleep quality, with the winter months often associated with lesser sleep (Husby and Lingjaerde, 1990; Pallesen et al., 2001; Johnsen et al., 2012). Sleeping issues were connected to certain seasonal photic and temperature extremes in research that looked at month-to-month variance in sleep disorders in six locations of Northern and Central Asia and Alaska (Putilov, 2017). A recent epidemiological study in Japan, which is in the temperate zone, revealed no correlation between insomnia and seasonality, in contrast to earlier data on mostly high-latitude regions (Itani et al., 2016). Meanwhile, in the general population of Finland, the prevalence of sleep dissatisfaction increased during summer (Ohayon et al., 2002).

The circadian time-keeping system's entrainment to photoperiodic shifts is a common explanation for sleep seasonality (Kohsaka et al., 1992; Binkley et al., 1990; Bliwise, 1993). However, it is noteworthy that individuals experienced significant sleep seasonality in places with slight fluctuation in the length of day (Buguet et al., 1990; Montmayeur and Buguet, 1992). For instance, according to a survey of young Africans living in a dry tropical region, more people awakened during the hotter months (Buguet et al., 1990). Although sleep seasonality is not well studied in Japanese people using objective measurements, two considerable research (Okamoto-Mizuno and Tsuzuki, 2010; Hashizaki et al., 2018) have been published.

Even though the sample size is small, actigraphic research of senior people found that total sleep time (TST), sleep efficiency (SE), and wake after sleep onset (WASO) were all less in the summer than in the winter (Okamoto-Mizuno and Tsuzuki, 2010). Using a contactless biomotion sensor, other sleep research found that summertime significantly increases wake after sleep onset (WASO), and decreases sleep efficiency (SE) (Hashizaki et al., 2018). However, the values of the sleep parameter in these two earlier investigations varied somewhat. For instance, the first research's sleep efficiency (SE) decreased marginally from winter to summer (winter: 88.0%, summer: 86.0%) but decreased by almost 10.0% in the second. While key conclusions of seasonal sleep differences have been made, there may inevitably be recalled limitation bias, as in most of these earlier researches. In addition, the Arctic Circle has only seen one prospective research that looked at the seasonality of sleep and sleep-related issues three times across distinct seasons (spring, autumn, and winter) (Friborg et al., 2014). However, prospective research has yet to explain seasonal differences in the amount of time spent sleeping and problems sleeping in the tropical and sub-tropical zone. Furthermore, no study has examined how accurately sleep varies throughout the four seasons.

In both clinical and non-clinical groups, seasonal variations in sleep have been documented (Kasper et al., 1989; Rosen and Rosenthal, 1991; Hardin et al., 1991; Wehr et al., 1991). Individuals with sleep and mood problems have the most dramatic seasonal variations in sleep duration (Reynolds and Kupfer, 1987; Wehr, 1988; Anderson et al., 1994). Numerous research (Hardin et al., 1991; Wehr et al., 1991; Rosenthal et al., 1984) have demonstrated that depression with hypersomnia is more common in the winter than in other seasons. According to Shapiro et al., (1994), a pattern of repeated winter hypersomnia has also been identified. Seasonal affective disorder (SAD) sufferers who experience depressive episodes in the autumn and winter that end in the spring typically sleep more than those who experience depressive episodes in the spring and summer (Hardin et al., 1991; Wehr, 1988; Rosenthal et al., 1984). Although, to a lesser extent, the general population exhibits the pattern of sleep seasonality found in people with mood and sleep disorders.

In a Maryland epidemiology research, 92.0% of communicated participants stated seasonal fluctuations in sleep duration; also, 27.0% thought the situation was a significant issue. Those who endorsed a winter mood pattern (i.e., reported "feeling worst" in winter) reported even longer sleep duration in winter (7.61 hours), with the average reported sleep length during winter being 7.41 hours compared to 7.05 hours during summer (Kasper et al., 1989). One study found a similar increase in sleep duration during the autumn and winter in both groups (Anderson et al., 1994), despite the majority of studies showing more extreme seasonal sleep changes in SAD patients than in the general population (Kasper et al., 1989; Rosen and Rosenthal, 1991; Hardin et al., 1991). Melatonin production, a key indicator of the biological night, was shown to be extended in winter in SAD patients but not in healthy controls in other research (Wehr et al., 2001). Geographic latitude is another element connected to the point of seasonal fluctuations in sleep duration. According to a population study conducted in Japan, northern cities had more considerable variations in sleep duration due to the winter season (Okawa et al., 1996).

In contrast, studies of college students imply that there is no seasonality in sleep patterns in African nations where seasonal variation in photoperiod is constrained by closeness to the equator (Buguet et al., 1990; Bogui et al., 2002). However, there is a discernible seasonal change in academic demand. Seasonal fluctuations in sleep may impact test-taking skills, study habits, and academic success. Seasonal sleep changes may be especially problematic for school students who have transferred to higher northern latitudes for the institute. Greater treatments that eventually improve academic performance may result from a more excellent knowledge of sleep seasonality among students.

The present study assessed how sleep patterns and the frequencies of sleep problems change across the seasons; we prospectively surveyed these items at four-time points in a year (March, June, September, and December) among school students. March and September are the equinoxes. An equinox is a period when day length and night-time length are approximately similar. For example, June is the longest day, and December is the shortest day. Therefore, they are the best reflector for seasonal, and the seasonal sleep patterns were conducted during these four months.

MATERIALS AND METHODS

The study was performed over four months, i.e., March, June, September, and December. The student sleep/wake patterns were collected using armband actigraphy for three consecutive days. The study includes 456 school students (216 male and 240 female). The different sleep parameters of the actigraphy report, such as bed-time, get-up time, time in bed (TIB), total sleep time (TST), sleep onset latency (SOL), sleep efficiency (SE), wake after sleep onset (WASO), and mid-sleep time were accessed. Morningness-Eveningness Questionnaire (MEQ) developed by Horne and Ostberg, (1976) was used to determine morningness-eveningness preference.

Statistical analysis

Data are presented as mean ± SE. One-way analysis of variance (One-way ANOVA) was used to analyze data, followed by Tukey's multiple comparisons test. Significance was taken at $P < 0.05$.

RESULTS

Figure 24 shows a comparison of actigraphy reports over four times of a year. Effect of season was observed in the get-up time ($F_{3,89}$ = 3.057, P = 0.0324; One way ANOVA; Fig. 24b), time in bed ($F_{3,81}$ = 4.407, P = 0.0064; One way ANOVA; Fig. 24c), total sleep time ($F_{3,76}$ = 7.108, P = 0.0003; One way ANOVA; Fig. 24d), sleep onset latency ($F_{3,78}$ = 9.981, P < 0.0001; One way ANOVA; Fig. 24e), wake after sleep onset ($F_{3,83}$ = 3.777, P = 0.0136; One way ANOVA; Fig. 24g), and mid-sleep time ($F_{3,88}$ = 3.683, P = 0.0150; One way ANOVA; Fig. 24h). Get-up time was significantly earlier during the month of June than December (P < 0.05; Tukey's multiple comparison test: Fig. 24b). Time in bed was significantly longer during the month of March and December, than June and September (P < 0.05; Tukey's multiple comparison test: Fig. 24c). No difference in time in bed was observed between March and December, and June and September (P > 0.05; Tukey's multiple comparison test: Fig. 24c). Total sleep time correspond the time in bed and total sleep time was significantly longer in March and December, than June and September (P < 0.05; Tukey's multiple comparison test: Fig. 24d). However, no difference in total sleep time was observed between March and December, and June and September (P > 0.05; Tukey's multiple comparison test: Fig. 24d). Maximum sleep onset latency was observed during the month of December, and it was significantly longer than all other time of the year (P < 0.05; Tukey's multiple comparison test: Fig. 24e). No difference in sleep onset latency was observed during March, June and September (P > 0.05; Tukey's multiple comparison test: Fig. 24e). Effect of season was reflected on wake after sleep onset and significant difference was observed during March and September (P < 0.05; Tukey's multiple comparison test: Fig. 24g). Mid-sleep time was also influenced by the time of year and mid-sleep time was advanced during the month of June, than other three times of the year (P < 0.05; Tukey's multiple comparison test: Fig. 24h). However, no significant difference in the timing of bed at four times of the year ($F_{3,88}$ = 0.2942, P = 0.8295; One way ANOVA; Fig. 24a), and sleep efficiency ($F_{3,88}$ = 0.8899, P = 0.4497; One way ANOVA; Fig. 24f), was observed.

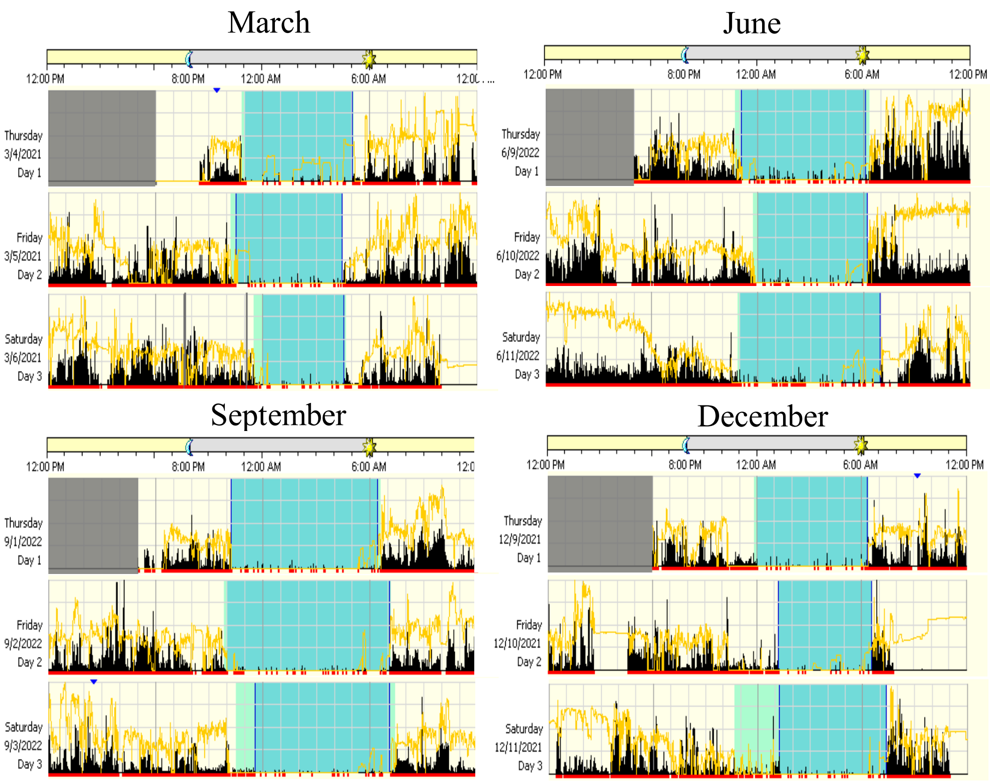

Figure 23: Representative actogram of the same participant during four months of the year

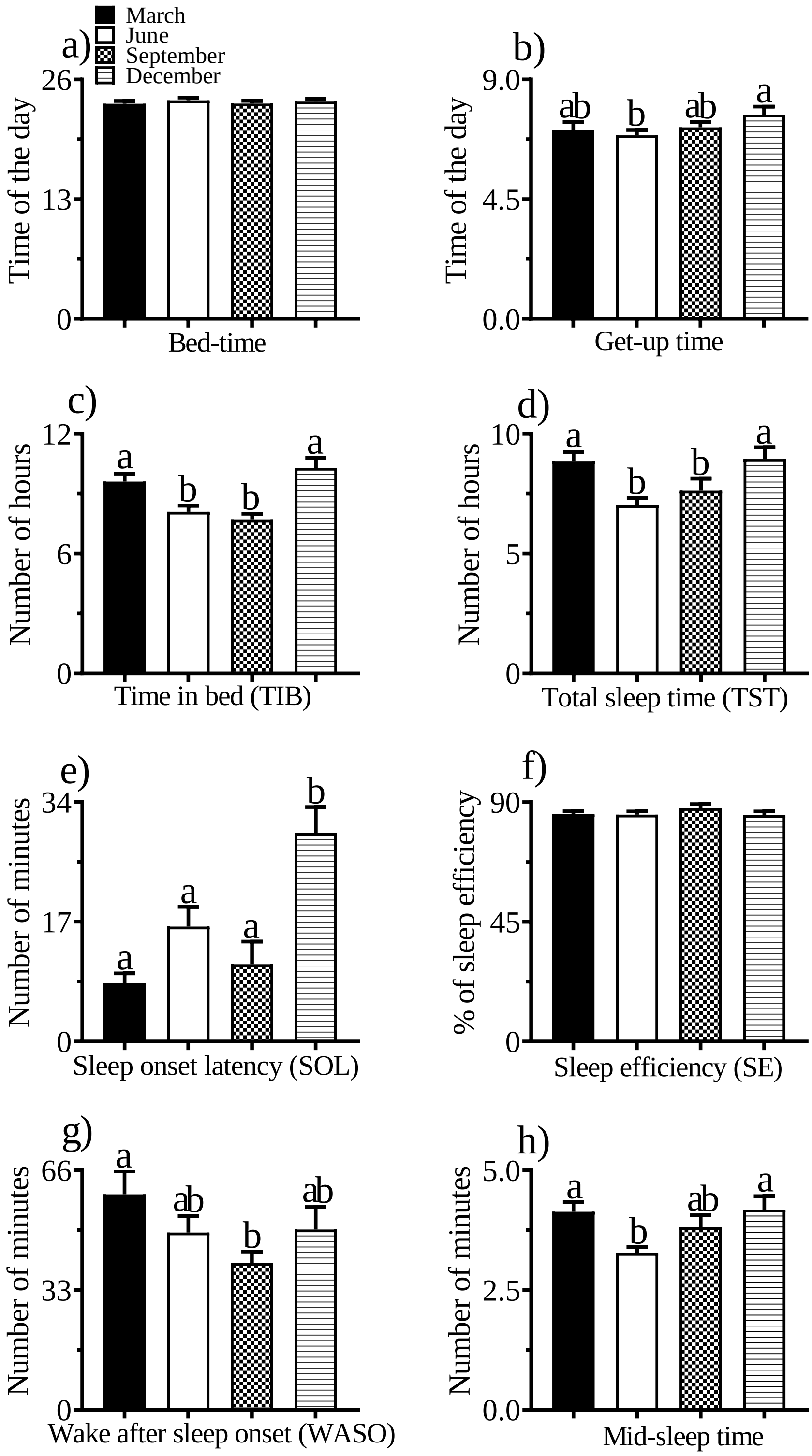

Figure 24: Data is represented as mean ± SE. Comparison of seasonal actigraphy report of sleep. Similar alphabets show no difference while different alphabets show significant difference among the four months.

A comparison of male actigraphy reports during the four months is shown in figure 25. Analysis of male participants actigraphy data shows significant differences in get-up time ($F_{3,422}$ = 15.23, P < 0.0001; One way ANOVA; Fig. 25b), time in bed ($F_{3,399}$ = 32.94, P < 0.0001; One way ANOVA; Fig. 25c), total sleep time ($F_{3,432}$ = 37.50, P < 0.0001; One way ANOVA; Fig. 25d), sleep onset latency ($F_{3,409}$ = 25.74, P < 0.0001; One way ANOVA; Fig. 25e), sleep efficiency ($F_{3,411}$ = 8.421, P < 0.0001; One way ANOVA; Fig. 25f), wake after sleep onset ($F_{3,391}$ = 5.170, P =0.0016; One way ANOVA; Fig. 25g), and mid-sleep time ($F_{3,89}$ = 3.465, P = 0.0196; One way ANOVA; Fig. 25h). Get-up time was significantly advanced during the month of June, and delayed during the month of December (P < 0.05; Tukey's multiple comparison test: Fig. 25b). No difference in get-up time was observed during the month of March, and September (P > 0.05; Tukey's multiple comparison test: Fig. 25b). Effect of season on time in bed was reflected and maximum time in bed was observed during the month of December, while minimum time in bed was recorded during June (P < 0.05; Tukey's multiple comparison test: Fig. 25c). Time spent in bed was longer in March than September (P < 0.05; Tukey's multiple comparison test: Fig. 25c). Total sleep time corresponds with time in bed in male participants and maximum total sleep time was observed during December, while minimum sleep time was observed during June (P < 0.05; Tukey's multiple comparison test: Fig. 25d). No difference in total sleep time was recorded between March and September, but it was longer than June (P < 0.05; Tukey's multiple comparison test: Fig. 25d). Effect of season on male sleep onset latency was observed, and it was significantly longer during the month of December, followed by June, while minimum sleep onset latency was observed during March and September (P < 0.05; Tukey's multiple comparison test: Fig. 25e). Interestingly we observed differences in male sleep efficiency and significantly higher sleep efficiency was observed during the month of September (P < 0.05; Tukey's multiple comparison test: Fig. 25f). Wake after sleep onset was significantly less during the month of September (P < 0.05; Tukey's multiple comparison test: Fig. 25g), than other times of the year. We also see differences in the mid-sleep time of male participants, and it was delayed during December, while it was advanced during September (P < 0.05; Tukey's multiple comparison test: Fig. 25h). No difference between March and June, and June and September was observed ($P > 0.05$; Tukey's multiple comparison test: Fig. 25h). There was no difference in the bed timing over the year among male participants ($F_{3,45} = 0.1425$, $P = 0.9339$; One way ANOVA; Fig. 25a).

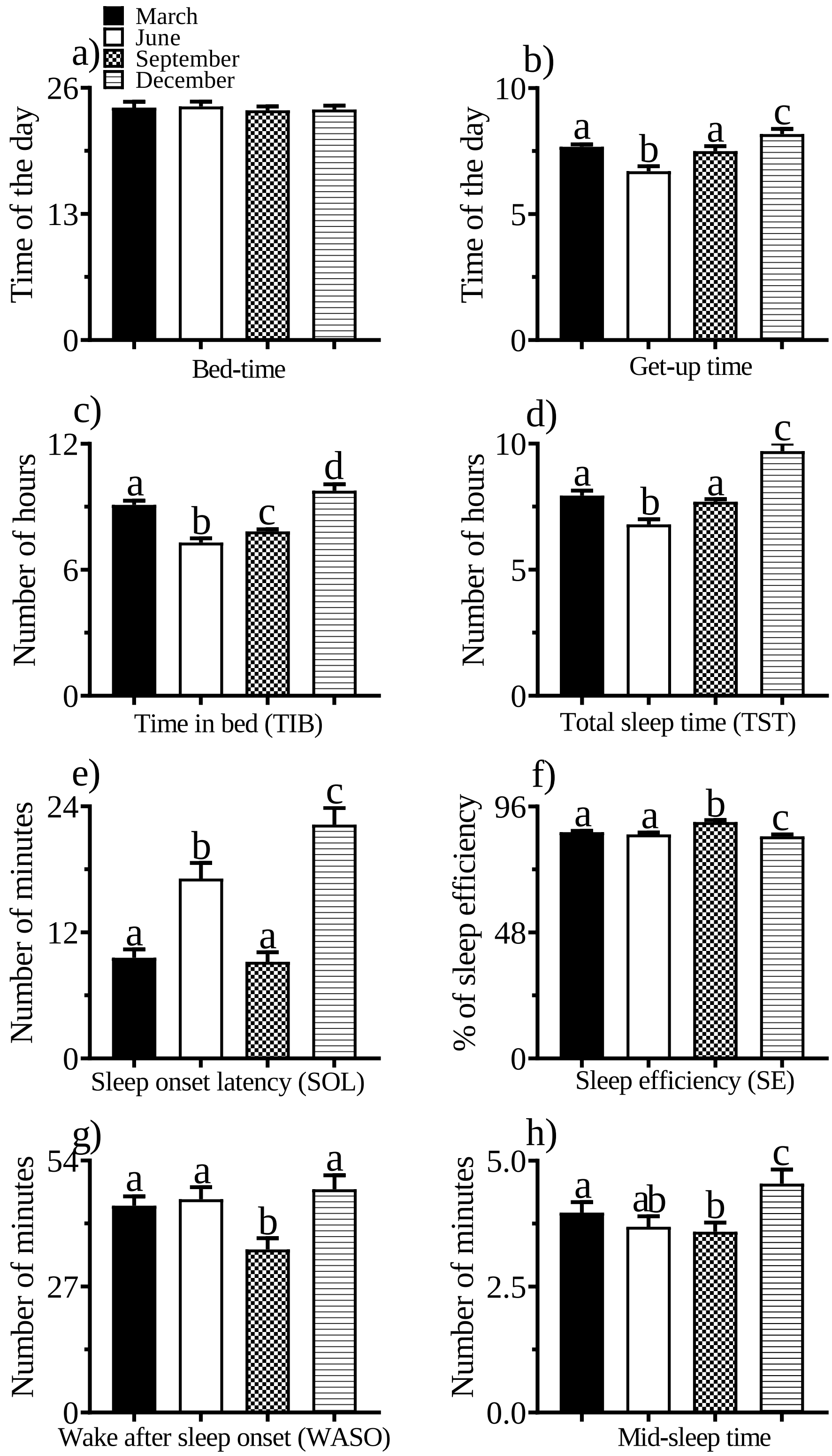

Figure 25: Data is represented as mean ± SE. Comparison of male seasonal actigraphy report of sleep. Similar alphabets show no difference while different alphabets show significant difference among the four months.

Figure 26 represents a comparison of actigraphy reports of the female during four times of the year. Significant differences in bed timing ($F_{3,40}$ = 4.582, P = 0.0037; One way ANOVA; Fig. 26a), get up time ($F_{3,399}$ = 7.511, P < 0.0001; One way ANOVA; Fig. 26b), time in bed ($F_{3,411}$ = 22.07, P < 0.0001; One way ANOVA; Fig. 26c), total sleep time ($F_{3,397}$ = 24.61, P < 0.0001; One way ANOVA; Fig. 26d), sleep onset latency ($F_{3,382}$ = 47.59, P < 0.0001; One way ANOVA; Fig. 26e), wake after sleep onset ($F_{3,378}$ = 22.29, P = 0.0016; One way ANOVA; Fig. 26g), and mid-sleep time ($F_{3,94}$ = 4.449, P = 0.0057; One way ANOVA; Fig. 26h), was observed. There was no difference in sleep efficiency ($F_{3,378}$ = 1.326, P = 0.2655; One way ANOVA; Fig. 26f).

Bed-timing was advanced in March and September in female, while it was delayed during June and December in female participants (P < 0.05; Tukey's multiple comparison test: Fig. 26a). Get-up time was significantly delayed during the month of December while it was advanced during the month of June (P < 0.05; Tukey's multiple comparison test: Fig. 26b). However, no difference in get-up time was observed during March and September (P > 0.05; Tukey's multiple comparison test: Fig. 26b). Time in bed was also influenced by the seasons and maximum time in bed was observed during December, while minimum time in bed was recorded during the month of June (P < 0.05; Tukey's multiple comparison test: Fig. 26c) while no difference of time in bed was observed during the month of March and September (P > 0.05; Tukey's multiple comparison test: Fig. 26c). Results of total sleep time correspond with the time of bed and maximum sleep time was recorded during December, while minimum sleep time was observed during June (P < 0.05; Tukey's multiple comparison test: Fig. 26d) having no difference in total sleep time between March and September (P > 0.05; Tukey's multiple comparison test: Fig. 26d). Maximum sleep onset latency was recorded during December, followed by June and September, while it was minimum during March (P < 0.05; Tukey's multiple comparison test: Fig. 26e). Wake after sleep onset was significantly longer during March, than other time of the year (P < 0.05; Tukey's multiple comparison test: Fig. 26g). Significantly, advanced mid-sleep time was recorded during March (P < 0.05; Tukey's multiple comparison test: Fig. 26h), but no difference in mid-sleep time was observed in other time of the year ($P > 0.05$; Tukey's multiple comparison test: Fig. 26h).

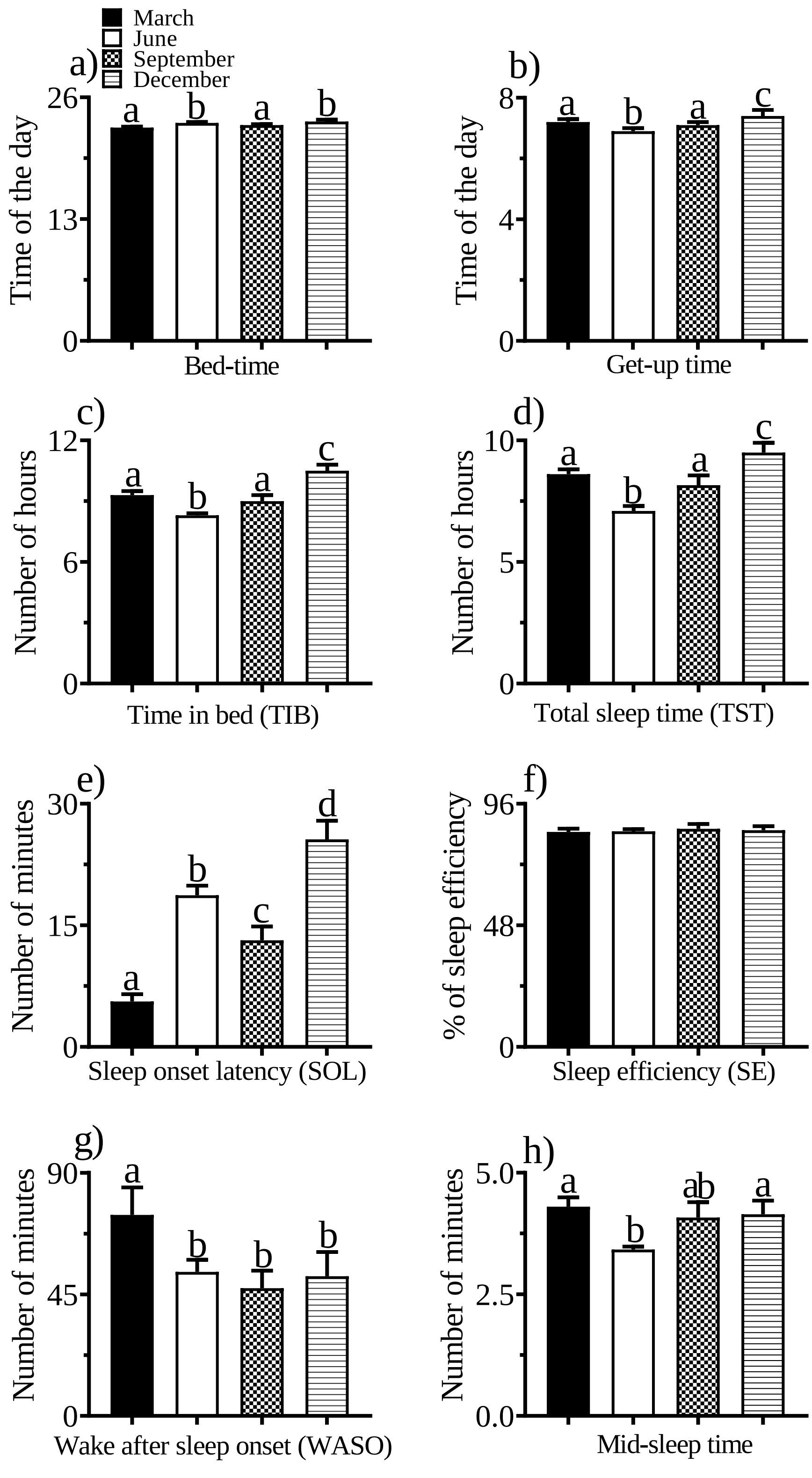

Figure 26: Data is represented as mean ± SE. Comparison of female seasonal actigraphy report of sleep. Similar alphabets show no difference while different alphabets show significant difference among the four months.

Actigraphy report of MT, NT, and ET participants during four times of the year is shown in figure 27. Among MT, significant difference was observed in time in bed ($F_{3,92}$ = 11.79, P < 0.0001; One way ANOVA; Fig. 27g), total sleep time ($F_{3,392}$ = 17.05, P < 0.0001; One way ANOVA; Fig. 27j), sleep onset latency ($F_{3,124}$ = 9.843, P < 0.0001; One way ANOVA; Fig. 27m), sleep efficiency ($F_{3,92}$ = 44.87, P < 0.0001; One way ANOVA; Fig. 27p), wake after sleep onset ($F_{3,92}$ = 45.50, P < 0.0001; One way ANOVA; Fig. 27s), and mid-sleep time ($F_{3,83}$ = 11.70, P < 0.0001; One way ANOVA; Fig. 27v). Among MT, significantly less time in bed was observed during September while maximum time in bed was observed during March (P < 0.05; Tukey's multiple comparison test: Fig. 27g). Total sleep time was significantly longer during June while, minimum sleep time was observed during December (P < 0.05; Tukey's multiple comparison test: Fig. 27j). Maximum sleep onset latency was recorded during December, while it was minimum during March (P < 0.05; Tukey's multiple comparison test: Fig. 27m). Sleep efficiency changed among MT participants across the year, and it was minimum during December, while maximum sleep efficiency was observed during June and September (P < 0.05; Tukey's multiple comparison test: Fig. 27p). Wake after sleep onset was minimum during September, while it was maximum during December (P < 0.05; Tukey's multiple comparison test: Fig. 27s). Change in mid-sleep time was observed and it was earlier during September and December, than March and June (P < 0.05; Tukey's multiple comparison test: Fig. 29v). There was no difference among MT participants in the bed timing and get up time during the four months (bed-time: $F_{3,9}$ = 1.248, P = 0.3489; One way ANOVA; Fig. 27a; get-up time: $F_{3,9}$ = 0.1879, P =0.9020; One way ANOVA; Fig. 27d).

Among NT participants, a significant difference in time in bed ($F_{3,72}$ = 5.892, P = 0.0012; One way ANOVA; Fig. 27h), total sleep time ($F_{3,124}$ = 6.431, P = 0.0004; One way ANOVA; Fig. 27k), sleep onset latency ($F_{3,65}$ = 3.199, P = 0.0290; One way ANOVA; Fig. 27n), wake after sleep onset ($F_{3,128}$ = 5.035, P = 0.0025; One way ANOVA; Fig. 27t), and mid-sleep time ($F_{3,130}$ = 1.158, P = 0.0056; One way ANOVA; Fig. 27w), was observed. We see the difference in time in bed across the seasons, and time in bed was significantly longer during March and December, than June and September (P < 0.05; Tukey's multiple comparison tests: Fig. 26b). Total sleep time was significantly less during June while maximum sleep time during December was observed ($P < 0.05$; Tukey's multiple comparison test: Fig. 29k). Minimum sleep onset latency was observed during March, while it was maximum during December ($P < 0.05$; Tukey's multiple comparison test: Fig. 29n). Wake after sleep onset was significantly differed between March and September ($P < 0.05$; Tukey's multiple comparison test: Fig. 29t), while in September, it was less than March. Mid-sleep point was advanced during June, than in December and March ($P < 0.05$; Tukey's multiple comparison test: Fig. 29w). No difference in the timing of bed ($F_{3,65} = 0.2844$, $P = 0.8365$; One way ANOVA; Fig. 27b), get up time ($F_{3,69} = 1.521$, $P = 0.2169$; One way ANOVA; Fig. 27e), and sleep efficiency ($F_{3,65} = 1.100$, $P = 0.3554$; One way ANOVA; Fig. 27q), was observed.

In ET participants, a significant difference was observed in all parameters; bed-time ($F_{3,92} = 13.24$, $P < 0.0001$; One way ANOVA; Fig. 27c), get-up time ($F_{3,91} = 8.271$, $P < 0.0001$; One way ANOVA; Fig. 27f), time in bed ($F_{3,92} = 45.55$, $P < 0.0001$; One way ANOVA; Fig. 27i), total sleep time ($F_{3,92} = 58.44$, $P < 0.0001$; One way ANOVA; Fig. 27l), sleep onset latency ($F_{3,92} = 10.36$, $P < 0.0001$; One way ANOVA; Fig. 27o), sleep efficiency ($F_{3,92} = 29.65$, $P < 0.0001$; One way ANOVA; Fig. 27r), wake after sleep onset ($F_{3,92} = 15.76$, $P < 0.0001$; One way ANOVA; Fig. 27u), and mid-sleep time ($F_{3,140} = 91.31$, $P < 0.0001$; One way ANOVA; Fig. 27x).

Bed-time was significantly delayed in September, than December and March ($P < 0.05$; Tukey's multiple comparison test: Fig. 27c). Get-up time also differed, and it was delayed during March and June, than September and December ($P < 0.05$; Tukey's multiple comparison test: Fig. 27f). Time in bed was longer during December and March, in comparison to June and September ($P < 0.05$; Tukey's multiple comparison test: Fig. 27i). Maximum sleep time was observed during December, while minimum sleep time was recorded during September ($P < 0.05$; Tukey's multiple comparison test: Fig. 27l). Significantly, less sleep onset latency was recorded during September, than other times of the year ($P < 0.05$; Tukey's multiple comparison test: Fig. 27o). Minimum sleep efficiency was recorded during September, while maximum efficiency was observed during March ($P < 0.05$; Tukey's multiple comparison test: Fig. 27r). Wake after sleep onset was significantly higher during September ($P < 0.05$; Tukey's multiple comparison test: Fig. 27u), than other months of the year, while mid-sleep time was significantly earlier during September ($P < 0.05$; Tukey's multiple comparison test: Fig. 27x).

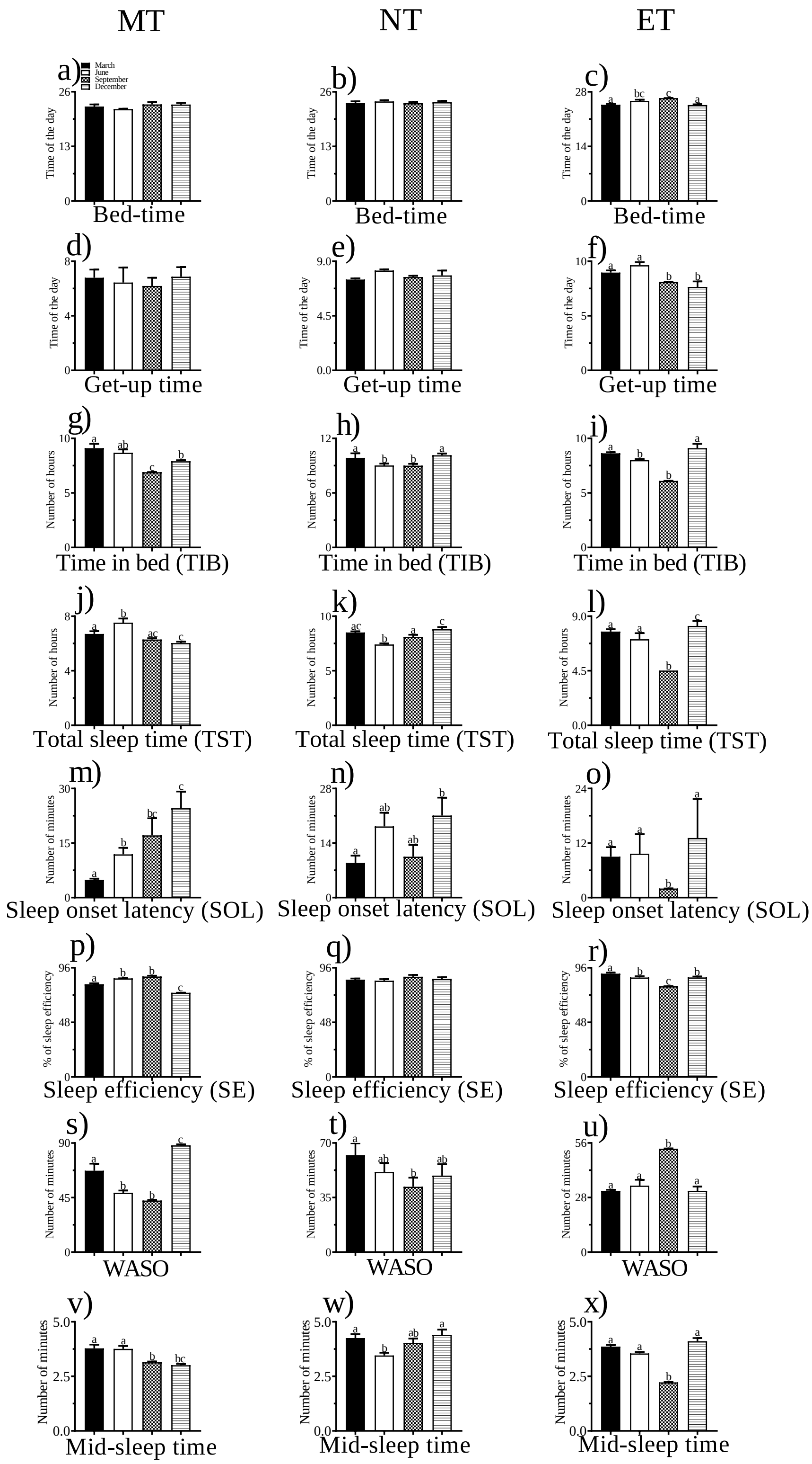

Figure 27: Data is represented as mean ± SE. Comparison of seasonal actigraphy report of MT, NT and ET. Similar alphabets show no difference while different alphabets show significant difference among the four months.

DISCUSSION

Influences of environmental time cues (Time of year, seasonal changes in day length) on human sleep behavior (Chang et al., 2011; Danilenko et al., 2000), mental well-being (Arendt, 2012; McClung, 2011; Sansone and Sansone, 2013), and energy metabolism (Patel et al., 2012; Van Staveren et al., 1986) support a link between these systems. Seasonal changes in sleep/wake patterns were identified by prospectively assessing data collected at four-time points (March, June, September, and December). The bed-timing was more or less similar across the season (Fig. 24a,25a,27a), consistent with the previous studies reported that seasonal variations were not confirmed in the bed-time (Li et al., 2021). However, gender-based analysis suggests that female, but not male participants showed changes in bed-time, and it differed when the natural photoperiod was either extremely long (June) or extremely short (December; Fig. 26a). A study included male subjects (20- 28 years age) of Sapporo, Japan also showed seasonality in the sleep timing, and other parameters of circadian rhythm (rectal temperature and plasma melatonin rhythm; Honma et al., 1992). Other human studies also reported seasonal changes in sleep timing (Binkley et al., 1990). In this study, volunteers' latest get-up time and latest total sleep time were centered around the months near the winter solstice when the days were short.

Further, volunteers' earliest get-up time and earliest total sleep time cantered in the months around the fall equinox (Binkley et al., 1990). Among 10 healthy male participants, the sleep timing and sleep electroencephalogram (EEG) parameters were studied during spring, summer, autumn, and winter under controlled conditions. A delay in the nocturnal sleep phase of about one and a half hours in winter than in summer was observed (Kohsaka et al., 1992). However, other studies that objectively assessed sleep in real-life settings could not find any seasonal shift in bed-time, but get-up time was significantly advanced during summer (Kohsaka et al., 1992; Hashizaki et al., 2018), suggesting that seasonal environment variations less influenced the bed-time in real-life settings. Socio-cultural factors such as lifestyle, work, social character, and family greatly impact bed-time in habitual sleep. Our study also suggests the idea as we also see a limited effect of season on bed-timing.

Our results suggest that changes in sleep duration might be more determined by differences in get-up time (Fig. 24b,25b,26b,27f) rather than bed-time, similar to Hashizaki et al., (2018). The findings from studies on sleep parameters are mixed. Ohayon et al., (2004) reported an increase in sleep latency with aging and a decrease in total sleep time and efficiency in a meta-analysis of 47 studies utilizing either PSG or actigraphy. According to Jean-Louis et al., (2000), females over 40 have longer sleep durations than males. While Tsai and Li, (2004), noted a longer sleep latency for females, most studies examining young adults showed no sex differences (Klei et al., 2005; Monk et al., 2000; Mongrain et al., 2005; Park et al., 2001). Using sleep diaries, they looked into 237 university students from all disciplines of study. Light and temperature in the modern world can be artificially controlled and adjusted (generally in indoor places) at different times of the year. Melatonin is a sleep-stimulating hormone, and it is one of the potential mechanisms responsible for the association between day length and duration of sleep. Artificial light may suppress melatonin production, and melatonin may not vary seasonally (Blume et al., 2019; Wehr et al., 1995; Wehr, 1998; Mclntyre et al., 1989; Haim and Zubidat, 2015). Although it remains unclear why sleep duration is longer in winter and shorter in summer, based on the finding that photoperiod has a substantial influence on sleep length (Wehr, 1992), the seasonal difference in day length is likely to be a leading factor contributing to the seasonality of sleep duration. The seasonal differences in sleep/wake cycles or sleep quality are commonly interpreted as a consequence of the entrainment of circadian rhythm to photoperiodic changes among seasons (Honma et al., 1987; Kohsaka et al., 1992; Husby and Lingjaerde, 1990; Pallesen et al., 2001; Winfree, 1987; Czeisler et al., 1989; Kantermann et al., 2007). However, remarkably, in the present study, the duration of sunlight contributions to sleep patterns was not investigated.

The older age group saw the most pronounced seasonal fluctuations in sleep duration. Although less prominent than in the older group, certain seasonality in their sleep length was revealed by the middle-aged group. Conversely, seasonal variation of sleep duration was not detected among the younger age group. This age difference is related to employment and educational level. In other words, since they lack social elements regulating their sleep, older people may exhibit natural seasonality in their sleep length. According to the young adult's outcomes, a seasonal variation in sleep duration was identified in the sub-group study of neither adolescents nor the young population. Previous epidemiological studies also found that seasonal changes in sleep duration were influenced by sex and residential area (Suzuki et al., 2019).

Females are more prone than males to exhibit the seasonality of mood and behavior, according to studies employing the Seasonal Pattern Assessment Questionnaire (SPAQ) (Kasper et al., 1989; Volkov et al., 2007), and females are more likely than males to experience seasonal affective disorder (SAD) (Magnusson, 2000). The concept of more extensive seasonal fluctuations in the duration of sleep among females than in males is unknown, as there are significant biological and behavioral changes between the sexes. To determine the reasons influencing gender variations in the seasonality of sleep, more research is required. The northern region showed the biggest geographical difference in sleep duration in seasonality. The length of sleep is significantly influenced by photoperiod (Wehr, 1992); hence, regional variances in the seasonality of sleep duration may have resulted from variations in seasonal day length. However, the geographical disparities in the seasonality of sleep could have been impacted by other things, including the weather and traditions. Future research should include measurements of these elements.

Less sleep is linked to worse health in young people (Steptoe et al., 2006). It may be relevant that shorter sleep duration in the winter is correlated with seasonal weight growth (Guzman et al., 2007), given that shorter sleep duration has previously been linked to weight gain, likely through lower leptin and raised ghrelin (Taheri et al., 2004). The underdiagnosis and under-treatment of seasonal affective disorder may be caused by the lack of knowledge about the condition (Agumadu et al., 2004). To improve students' emotional and physical health and academic performance, substantial efforts must be made to investigate, treat, and raise awareness of seasonal fluctuations in school children's mood, performance, and sleep.

In summary, this study suggests that sleep properties are influenced by gender and time of the year. For this study, the sample size could be a potential limitation; therefore, in future studies, a larger sample size should be investigated to confirm the association between the chronotype and seasonal sleep properties.

SECTION 5. CHANGES ASSOCIATE WITH CHRONOTYPE, SLEEP PATTERN AND DEPRESSION LEVELS AMONG SCHOOL STUDENTS DURING PANDEMIC COVID-19 LOCKDOWN, AND POST-LOCKDOWN ONLINE CLASSES

ABSTRACT

The outbreak of the pandemic coronavirus (COVID-19) had a significant impact on the well-being of individuals and the worldwide population, influencing generally health of a community, financial, societal, and protection implications. The outbreaks differ among and within the countries, though some common response actions are employed in all the nations, like social distancing, a different phase of lockdown, as well as stay-at-home. Furthermore, various circumstances of the day-to-day activities such as educational and different kinds of work become online education and work from home and consequently have an emotional impact among the entire population. The present study was executed in three phases. The first phase of the study was performed from April to July, 2019, while the second phase was conducted between April to May, 2020, and the third phase was conducted from July to August, 2021. 100 school students (46 male and 54 female) participated in the study, and the age group of the participants ranged between 14-20 years. A different self-administered questionnaire was used in the study, such as Morningness-Eveningness Questionnaire (MEQ), Epworth Sleepiness Scale (ESS), Pittsburgh's Sleep Quality Index (PSQI), and Zung Self-Rating Depression Scale (SDS). Our result indicates that during the lockdown and online classes, participants of ET increased, whereas it was decreased in MT and NT. Furthermore, higher self-rating depression levels, more daytime sleepiness, and reduced sleep quality were identified during the lockdown and online classes, irrespective of gender. Overall, the study suggests that lockdown and social isolation during post-lockdown had negative impact on mental health, increased the level of daytime sleepiness, and deprived sleep quality among school students.

INTRODUCTION

COVID-19 was a unique situation faced by the entire world community at the beginning of the year 2020. During the pandemic-imposed lockdown, schools, colleges, offices, markets, and all social activities were banned, with the exception of those employed in essential services; people were not allowed to go out of their homes; thereafter, the government made an assertive decision, ordering all the schools and universities to roll out their teaching online. It was a unique situation for teachers and students, and then for the majority of teachers and students, this was the first time they were exposed to online learning. Humans are social animals as they spend a significant time of the day in social activities. Prolonged home confinement may result in reduced physical activity, elevating stress levels due to social isolation, and the difficulties of engaging in a satisfying activity like outdoor sports. It may result in increased mental health challenges (Leigh-Hunt et al., 2017; Zolotov et al., 2022; Xiang et al., 2020). A chronotype represents the propensity of an individual to prefer to engage in an activity at a particular time during a 24-hour period (Chelminski et al., 1997). “Eveningness” and “morningness” are the two extreme conditions of chronotype. There are three chronotypes, as individuals prefer evening or late or else early daytime, correspondingly. At the same time, neither type of person is more flexible to perform the activity at any given time (Adan et al., 2012). The chronotypes may be associated with age (Paine et al., 2006), sex (Paine et al., 2006; Muro et al., 2009), working schedule (Pearson, 2004; Randler, 2008), or personality (Muro et al., 2009; Digdon and Howell, 2008; Tonetti et al., 2009).

Good quality of sleep is essential for health (Hall et al., 2015; Noland et al., 2009). Healthy sleep can be defined as having sufficient duration, efficiency, satisfaction, and regular sleep/wake patterns (Blunden and Galland, 2014). Poor quality sleep may lead to behavioral and physiological changes and may lead to depression, mood swings, aberrant behavior, obesity, and cardiovascular problems (Hall et al., 2015; Arora and Taheri, 2015; Randler, 2011; Wittmann et al., 2006). Various factors, such as the availability of artificial light at night, the use of social media and other information technology, and modern lifestyle, have a dominating effect on the sleep quality patterns (Vollmer et al., 2013). The pandemic significantly affected all the sectors like industries, education, etc. In view of the above, the study was conducted to understand the effect of the pandemic lockdown and home confinement on chronotype, sleep quality, daytime sleepiness, and depression levels in adolescents.

MATERIALS AND METHODS

The present study included 100 school students from different schools within Aizawl, 46 males, and 54 females. The age group ranged from 14-20 (average age 16 years) years. The study was conducted to understand the consequences of lockdowns due to the COVID-19 pandemic and subsequent online educational modes on sleep and stress levels among school students. This longitudinal study was performed in three phases. Phase one of the study was conducted between April 2019 and July 2019, while the second phase was done between April to May 2020 (no class during the second phase), and the third phase was conducted during July and August, 2021. All the students who participated during the lockdown and online classes answered the same questionnaire during their offline classes (April 2019 to July 2019). The students were approached individually via school administration in the first phase of the study. Their personal information, like age, sex, and class, was collected. A self-administered questionnaire was circulated and collected during school hours.

The second and third phases was conducted through an online questionnaire. The first phase of the study included more than 100 school students, but during the second and third phases, some students did not participate, so their data was not included in the analysis (the dropout rate was 20.0-22.0%). Further, incomplete questionnaires were excluded from the study. The participants included in the study belonged to the middle/upper middle class with access to smartphones and internet facilities. Their chronotype was assessed using Morningness-Eveningness Questionnaire (Horne and Osterberg, 1976). Daytime sleepiness was evaluated by the Epworth Sleepiness Scale (ESS) (Johns, 1999). Pittsburgh's Sleep Quality Index (PSQI) (Buysse et al., 1988) was used for the assessment of different sleep habits. Zung Self-Rating Depression Scale (SDS) (Zung, 1965) was used for the measurement of the level of depression in students.

Statistical analysis

Data are represented as mean ± SEM. One-way ANOVA, followed by Newman-Keuls multiple comparison test, was executed to determine the differences during offline class, lockdown, and during online class periods. Significance was taken at $P < 0.05$.

RESULTS

The percentage of chronotype among students was calculated. During offline classes, NT was highest 64.0% in the population, followed by MT 26.0% and ET 10.0% (Fig. 28a). However, during COVID-19 lockdown, there was a change in the percentage of chronotype; both NT and MT percentage reduced to 54.0% and 16.0%, respectively, while ET percent increased to 30.0% (Fig. 28d). During post-lockdown online classes, NT percentage further decreased to 48.9%, while MT was 19.1%, however, ET was 31.9% (Fig. 28g). Gender-wise analysis revealed that during offline classes among males, 56.5% were NT, 30.4% were MT and 13.0% were ET (Fig. 28b), while during lockdown only 39.1% males reported themselves as NT, 17.4% were found to be MT, and ET percentage increased to 43.5% (Fig. 28e). During online classes, only 13.6% were MT, 40.9% were NT, and 45.4% were reported to be ET (Fig. 28h). In female, 70.3% were reported for NT during offline classes, 22.2% were reported as MT, while only 7.4% were found as ET (Fig. 28c). During lockdown, 66.6% reported themselves as NT, 14.8% reported as MT, while 18.5% participants were ET respectively (Fig. 28f), while during online classes, 24.0% were MT, 56.0% NT, and 20.0% were reported as ET (Fig. 28i).

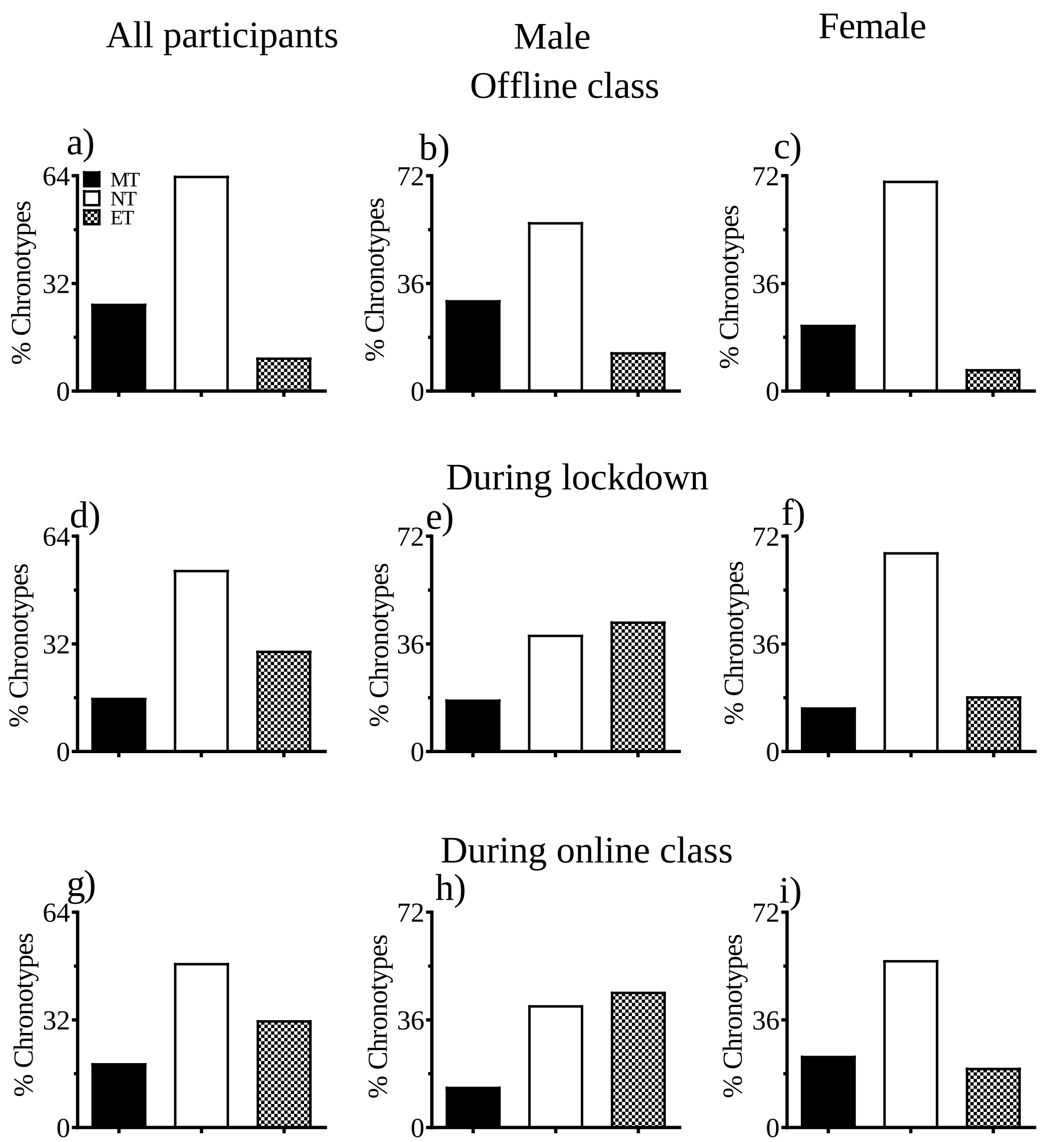

Figure 28: Data is represented as percentage. Chronotype percentage of school students during offline class, during lockdown and online class.

Figure 29 represents a comparison of ESS and SDS during the three study phases. When data were compared between offline classes, lockdown, and during online classes, a significant difference was observed in ESS scores ($F_{2,297} = 23.55$, $P < 0.0001$; One-way ANOVA; Fig. 29a). On comparing gender-wise ESS score, a significant difference was observed in both males and females (male: $F_{2,135} = 6.819$, $P = 0.0015$; Fig. 29b; female: $F_{2,159} = 20.85$, $P < 0.0001$; One-way ANOVA; Fig. 29c) during the lockdown, and during online classes. A significant difference was also observed in self-rating depression levels ($F_{2,297} = 10.57$, $P < 0.0001$; One-way ANOVA; Fig. 29d). Irrespective of gender, depression levels (SDS) were significantly higher during lockdown (male: $F_{2,134} = 6.640$, $P = 0.0018$; Fig. 29e; female: $F_{2,157} = 4.398$, $P = 0.0139$; One-way ANOVA; Fig. 29f).

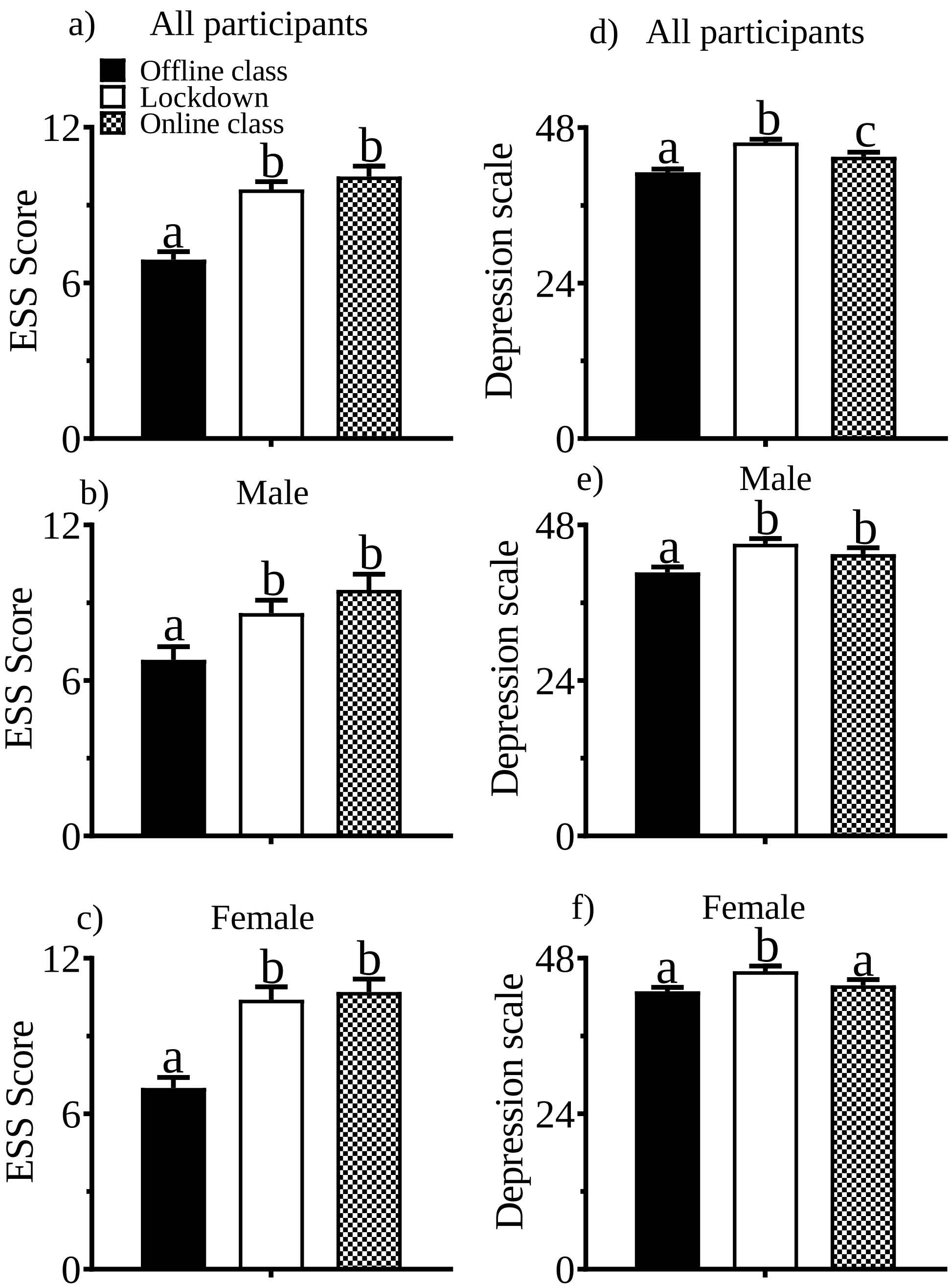

Figure 29: Data is represented as mean ± SE. Comparison of ESS and SDS during the three study phases. Similar alphabets show no difference while different alphabets show significant difference among the three phases.

A comparison of global PSQI score and different sleep habits of PSQI scores was shown in figure 30. The highest global PSQI score was observed during lockdown ($F_{2,293}$ = 7.035, P = 0.0010; One-way ANOVA; Fig. 30a), than during offline or online classes. Analysis of different PSQI sleep habits during offline classes, lockdown, and during online classes revealed significant differences in get-up time ($F_{2,291}$ = 63.39, P < 0.0001; One-way ANOVA; Fig. 30c), and in the score of sleep quality ($F_{2,219}$ = 3.714, P = 0.0259; One-way ANOVA; Fig. 30d), a score of sleep latency ($F_{2,921}$ = 8.790, P = 0.0002; One-way ANOVA; Fig. 30e), and the score of sleep duration ($F_{2,921}$ = 27.75, P < 0.0001; One-way ANOVA; Fig. 30f). However, the difference in bed-time ($F_{2,921}$ = 0.1416, P = 0.8681; One-way ANOVA; Fig. 30b) was not observed. Gender-wise comparison of responses of global PSQI score was compromised only in females as no significant differences were observed in males (male: $F_{2,134}$ = 0.5601, P = 0.5725; Fig. 30g; female: $F_{2,157}$ = 3.820, P = 0.0240; One-way ANOVA; Fig. 30m). Significant differences were also observed in different sleep habits of PSQI in both males and females: get-up time (male: $F_{2,155}$ = 3.849, P = 0.0234; Fig. 30i; female: $F_{2,155}$ = 70.50, P < 0.0001; One-way ANOVA; Fig. 30o) and the score of sleep duration (male: $F_{2,133}$ = 14.74, P < 0.0001; One-way ANOVA; Fig. 30l; female: $F_{2,155}$ = 14.60, P < 0.0001; One-way ANOVA; Figure 30r). However, the difference in score of sleep quality was observed only in male ($F_{2,113}$ = 7.253, P = 0.0011; One-way ANOVA; 2,113 Fig. 30j), while sleep latency score was different only in female ($F_{2,155}$= 9.767, P = 0.0001; One-way ANOVA; Fig. 30q). No differences in bed-time in either sex (male: $F_{2,155}$ = 0.2320, P= 0.7932; One-way ANOVA; Fig. 30h; female: $F_{2,155}$ = 1.632, P = 0.1988; One-way ANOVA; Fig. 30n), sleep latency in male ($F_{2,133}$= 1.582, P = 0.2094; One-way ANOVA; Fig. 30k), and score of sleep quality in female ($F_{2,103}$= 0.0640, P = 0.9380; One-way ANOVA; Fig. 30p), was observed.

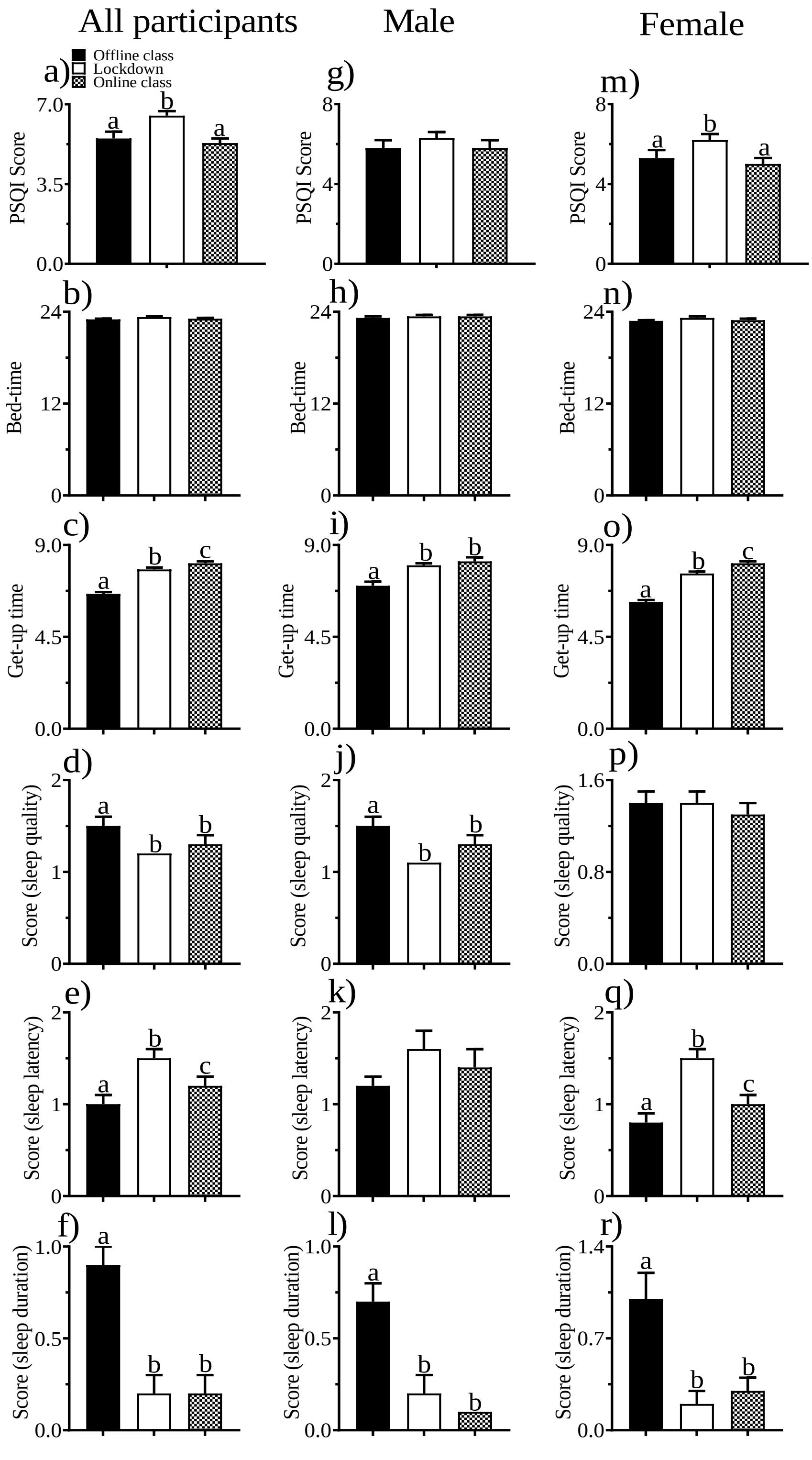

Figure 30: Data is represented as mean ± SE. Comparison of global PSQI score and different sleep habits during the three study phases. Similar alphabets show no difference while different alphabets show significant difference among the three phases.

DISCUSSION

The percentage of NT was highest 64.0% during offline classes in the study population, 26.0% were identified as MT, while only 10.0% were ET (Fig. 28a). However, there was a change in the percentage of chronotype during the COVID-19 lockdown in both NT and MT percentage, and reduced to 54.0% and 16.0%, respectively, while ET percent increased to 30.0% (Fig. 28d). Similarly, during post-lockdown online classes, NT percentage further decreased to 48.9%, while slight improvement was observed in the MT, and was 19.1%; however, ET percent was almost similar to that of lockdown, and was 31.9% (Fig. 28g). Gender-wise analysis also showed the effect of the pandemic COVID-19 lockdown and post-lockdown online classes in the percentage of chronotype (Fig. 28b-i). The increase in late chronotype in the population may potentially be due to the closure of schools during the lockdown and subsequent delay of school timing during post-lockdown online classes. School timings were delayed by one hour during online classes in relation to offline classes before COVID-19 conditions. All the participants were school students, and during the lockdown, all the classes were suspended; hence they could not participate in the time-table based school teaching and were free to schedule their daily calendar and were in the phase of social free-running (no time-table for study and other activities).

Previous studies have reported the effect of social networking sites and digital media on the daily habits of adolescents (Vernon et al., 2015; Vernon et al., 2017). The current study did not include the frequency of digital media usage. However, the study conducted on the Italian population showed increased use of digital media during lockdown (Cellini et al., 2020). The influence of social isolation (due to the COVID-19 lockdown and subsequent online classes) on chronotype was suggested by only a few reports. Delay in bed-time and get-up time during social isolation is reported (Leone et al., 2020). The study observed a change in chronotype between pre-COVID-19, during the pandemic lockdown, and post-lockdown but during online classes. These findings suggest that during social isolation and without a rigorous schedule, both MT and NT tend to delay bed-timing and get-up time; as a result, a higher percentage of students reported themselves as ET than during pre-

COVID-19 situations. These findings are different from the reports on university students, where the effect of lockdown was more on ET students than NT and MT (Leone et al., 2020).

There was a significant effect of lockdown and online classes on daytime sleepiness (Fig. 29a-c). ESS score was significantly higher during the lockdown and online classes than offline classes (Fig. 29a). Depression levels were significantly higher during the lockdown and online classes than offline classes (Fig. 29d). However, in males comparison to offline classes, depression levels were higher even during online classes (Fig. 29f). In addition to the sleep/wake cycle, COVID-19 greatly influenced mental and physical health. The study showed higher self-rating depression levels among students during this pandemic lockdown and online classes (Fig. 29d). The fear of COVID-19 was observed in the mental health among university students (Zolotov et al., 2022) and health professionals (Xiang et al., 2020). It could be due to excessive use of social media (Pantic et al., 2012). Rather than an assumption, increased daytime sleepiness, deprived sleep quality, and higher levels of depression among school students during the lockdown and online classes than during offline classes were identified. Similar responses were found in the study conducted on the Italian population. In the Italian population, during the second week of lockdown, marked changes were observed in sleep/wake rhythms and delayed bed-timing; lower sleep quality was reported. This decrease in sleep quality was associated with people who reported higher depression, anxiety, and stress symptomatology (Cellini et al., 2020). Similarly, the highest global PSQI scores during lockdown were observed in the overall participants (Fig. 30a) and among females (Fig. 30m). There was a significant difference in the PSQI different sleep habits among all participants as well as on the gender basis (Fig. 30). During offline classes, good quality of sleep was accessed in 30.0% students, while it was reduced to 20.0% during lockdown, and was 23.0% during online classes. Among males, during offline class, 17.0% of participants had good quality sleep, which decreased to 9.0% during the lockdown. However, during online classes, it increased and was similar to during offline classes (18.0%). While in females during offline classes, 40.7% scored good sleep quality, then the score decreased during lockdown to 29.6% and 28.0% during online classes. Few other studies resulted in similar findings and revealed poor sleep quality, high anxiety, high distress, and poor mental health (Casagrande et al., 2020; Franceschini et al., 2020; Li et al., 2020). Web-based studies in China also showed a high prevalence of generalized anxiety disorder and poor sleep quality in public (Huang and Zhao, 2020).

In another study conducted on three European societies (Austria, Germany, Switzerland), the COVID-19 restrictions reduced social jetlag and social sleep restriction, with a concomitant increase in sleep duration but reduced sleep quality (Blume et al., 2020). The study conducted on university students resulted in an increase in bed-time hours, sleep latency, and get-up time during the COVID-19 crisis without affecting total sleep time and time in bed. Overall, the study reported worsened sleep quality (Pittsburgh's Sleep Quality Index total score) during lockdown in university students (Marelli et al., 2021).

The study suggested increased levels of anxiety-related symptoms during lockdown. However, the mood was not different between males and females during the COVID-19 outbreak, different from previous research that reported women were more prone to anxiety than men (Guo et al., 2016; Gao et al., 2020). The present study observed higher self-rating depression rates during the lockdown and subsequent online classes (Fig. 29d,e,f). Gender-wise differences were observed in the self-rating depression levels, and males had higher depression levels during lockdown and online classes, while in females, higher depression levels were reported only during lockdown (Fig. 29e,f). Although the study expected better sleep quality and less depression during the pandemic lockdown, the results were the opposite because students did not follow any daily routine, overuse of social media, going to bed at late hours, social isolation due to the lockdown and, the mental pressure to be the situation of increase infection rate of COVID-19. The gender-based effect of lockdown has been reported in Italian university students, and the impact of lockdown was more significant in females than males (Marelli et al., 2021). This is the first longitudinal study conducted on the same group of participants during the pre-COVID-19 situation, during lockdown and post-lockdown under socially restricted conditions.

In conclusion, delay in chronotype, increased daytime sleepiness, deprived sleep quality, and higher self-rating depression rates among school students of Aizawl were observed during the pandemic lockdown. This study has limitations as the study was conducted only on 100 participants, which was less, but indicative enough to understand the effect of lockdown on adolescents. Data from a larger sample size may be more beneficial for better understanding. These results may be significant to offer psychological support on most vulnerable section, i.e., students and educational interferences on sleep quality, circadian rhythms, as well as mental controlling in order to possess a good sleep/wake cycle and day-to-day schedule throughout social isolation.

SECTION 6. CHRONOTYPE-DEPENDENT ACADEMIC PERFORMANCES AMONG SCHOOL AND UNIVERSITY STUDENTS

ABSTRACT

Students' academic success is influenced by their sleep habits and other unique sleep behavior. Adolescents' academic success is crucial for their psychological development and adult readiness. Teenagers' academic performance and learning capacity may be impacted by sleep quality or amount, since sleep is vital for concentration and memory. One of the main goals for students is to do better academically. Students might boost their chances of getting accepted to further education, win an award, and gain more self-confidence by increasing their academic performance. This study looked at disparities in teenage academic performance depending on chronotype and gender and compared them with the data of adolescents with university students. 427 school students and 437 university students participated in the study. The study employed the self-administered Morningness-Eveningness Questionnaire (MEQ), and each participant's grade points were tallied. According to the findings, MT participants had better academic achievements than NT and ET participants, and these findings were independent of school or university students. Further, irrespective of school or university students, females had better academic scores than males. These findings suggest that chronotype and gender influence academic success in turn to scores achieved.

INTRODUCTION

Sufficient and high-quality sleep is crucial for teenagers' health, well-being, and academic achievement (Hall et al., 2015; Noland et al., 2009). An adequate, efficient, satisfying, and regular sleep/wake cycle are all characteristics of good sleep (Blunden and Galland, 2014). Irregular and insufficient sleep can cause melancholy, mood swings, aberrant behaviors, obesity, and cardiovascular issues (Arora and Taheri, 2015; Hall et al., 2015; Randler, 2011b; Wittmann et al., 2006). An adolescent sleep pattern is related to numerous sociodemographic features. Chronotype delays brought on by age- and puberty-related changes in sleep timings cause social jet lag (Knutson, 2005; Olds et al., 2010). Humans and animal models have been used to study variations in sleep/wake rhythms and their relationships to biological, psychological, and behavioral processes (Jongte and Trivedi, 2021; Korczak et al., 2008; Marpegan et al., 2009). A chronotype shows a propensity for the circadian rhythm. It may be described as a person's tendency to prefer to do something and sleep at a specific time over 24 hours (Chelminski et al., 1997). The two chronotype extremes of "eveningness" and "morningness" are when respondents choose to schedule their activities for late at night or early in the morning, respectively (Adan et al., 2012). Morningness-eveningness is correlated with individual differences such as age (Paine et al., 2006), sex (Muro et al., 2009; Paine et al., 2006), working schedule (Pearson, 2004; Randler, 2008), or personality (Adan et al., 2010a, 2010b; Digdon and Howell, 2008; Muro et al., 2009; Tonetti et al., 2009). Furthermore, morningness is linked to higher conscientiousness (Tonetti et al., 2009), and general and work activity (Muro et al., 2009). In contrast, eveningness is linked to lower self-control, higher procrastination, and higher neuroticism, higher novelty-seeking, and more moderate harm avoidance (Adan et al., 2010a).

Some studies have found an association between chronotype and daytime sleepiness, napping behavior, and sleep latency during naps (Rosenthal et al., 2001), among other outcomes (Martin et al., 2016; Taillard et al., 1999). Adolescence is a crucial time when a person experiences biological and social variations and may have irregular sleep patterns. The sleep timing is delayed during adolescence due to physiological and hormonal changes linked to alterations in the circadian and homeostatic control of sleep (Carskadon et al., 1993). Although the circadian system is mainly responsible for determining chronotype, common adolescent behaviors like the pressure to perform well in school, late-night electronic use, socializing, and high-fat diets can change chronotype by delaying the onset of melatonin and lengthening the circadian cycle (Kohsaka et al., 2007; Roenneberg et al., 2007).

Evidence showed that teenage lifestyle behaviors, such as eating habits and sleep patterns, are related (Garaulet et al., 2011; Kauderer and Randler, 2013; Schaal et al., 2010). A healthy sleep schedule is essential for brain function as it can improve memory and rational abilities. When their melatonin release is postponed during puberty, adolescents prefer to go to bed- and wake-up later (Carskadon and Acebo, 1997). On holidays or weekends, people tend to go to bed later and sleep longer (Gibson et al., 2006; Loessl et al., 2008; Warner et al., 2008; Wolfson, 2003; Wolfson and Carskadon, 1998), which reflects their preference. As school performance is closely related to later educational and employment attainment, the relationship between sleep and academic performance is an important study area, particularly in the last adolescent years (De Ridder et al., 2012). There are several possible processes and channels through which sleep and academic achievement can be connected. Teenagers may have direct or indirect effect from sleep deprivation (Curcio et al., 2006; Hysing et al., 2015). Confounding variables, such as socioeconomic status, which has been linked to sleep quality (Boe et al., 2012), and academic achievement (Sirin, 2005), may contribute to some of the connections.

Numerous studies strongly imply that students are frequently chronically sleep-deprived and that timing of sleep, as well as its quality and quantity, are related to students learning abilities and academic achievement (Curcio et al., 2006; Wolfson and Carskadon, 2003). Academic success is recognized to be substantially influenced by intellect, personality characteristics, and study techniques (Aluja-Fabregat and Blanch, 2004, Laidra et al., 2007, Lounsbury et al., 2003). According to many studies, academic performance is also influenced by sleep habits, class schedules, and test dates (Wolfson and Carskadon, 2003). Studies have found that MT performs better academically than ET, as evidenced by the higher grades MT receives in learning evaluations (Kolomeichuk et al., 2016; Medeiros et al., 2001; Preckel et al., 2013; Rahafar et al., 2016; Randler and Frech, 2006; Smarr, 2015). A minor but substantial link between morningness and academic success was found by a meta-analysis of the data from 13 of this research (Preckel et al., 2011). Studies also imply that adolescents with morning chronotype do better than adolescents with evening chronotype in schools with early school hours (Zerbini and Merrow, 2017; Tonetti et al., 2015; Preckel et al., 2011, Goldin, 2020).

The knowledge available among Indian students is limited. To create some baseline data for the Indian population, the current study set out to collect information from school students in Aizawl, Mizoram, and compare it with those at the university. All schools in the Aizawl municipal corporation region have the same start time of 9:00 A.M. It also makes it possible to analyze a diverse population who attends various schools but shares the same school timing. Additionally, the school's start time is relatively early compared to the start times of many other schools in other large cities.

MATERIALS AND METHODS

The study was performed among school students, and the observations were compared with the university students. Both the school and university students were selected from Aizawl, Mizoram. School students were informed about the study via school administration, and university students were informed through university faculty members. There was no selection bias in the study. The study included 427 school students (class 9^{th} to 12^{th}); 205 were males, and 222 were females, while 437 university students (postgraduate students), 203 were males, and 234 were females. At the beginning of the study, volunteers were informed about the study and its purpose, and consent was obtained. The volunteers could withdraw their participation from the study at any time. Individual confidentiality was maintained throughout the study. The age group of volunteers from school students ranged between 14 to 20 years (16.8±0.1), while among university students age group ranged from 19 to 29 years (22.7±1.1). Subjects were asked to answer Morningness-Eveningness Questionnaire (MEQ; Horne and Osterberg, 1976) was used for the measurement of their chronotype. Incomplete questionnaires were excluded from the analysis. The questionnaire was randomly distributed to the students. Individual grade points were collected.

Statistical analysis

Student t-test was applied to check the differences when comparing two point values. One-way analysis of variance (one-way ANOVA) was used to determine the significant differences among groups. Tukey's multiple comparisons test were used for significant interactions. Significance was taken at $P < 0.05$.

RESULTS

Gender basis comparison of all participants (both school and university students) suggests effect of gender on academic performances (Fig. 31a). Overall females had achieved higher academic scores than males ($P = 0.0235$; Unpaired t-test; Fig. 31a). When we compared chronotype-dependent academic performances among all the participants, effect of chronotype was reflected in academic performances ($F_{2,861} = 26.43$, $P < 0.0001$; One way ANOVA; Fig. 31b). MT achieved better academic scores than NT and ET ($P < 0.05$; Tukey's multiple comparisons test; Fig. 31b). We do not see a significant difference in grade points between NT and ET ($P > 0.05$; Tukey's multiple comparisons test; Fig. 31b). Chronotype-dependent comparison of grade points among all male participants shows the significant difference ($F_{2,405} = 3.238$, $P = 0.0403$; One way ANOVA; Fig. 31c). Higher academic scores was observed among MT, than NT and ET ($P < 0.05$; Tukey's multiple comparisons test; Fig. 31c). However, there was no difference among males NT, and ET were observed ($P > 0.05$; Tukey's multiple comparisons test; Fig. 31c). Females had similar responses ($F_{2,446} = 3.225$, $P = 0.0407$; One way ANOVA; Fig. 31c), as MT achieved significantly higher academic scores than NT, and ET ($P < 0.05$; Tukey's multiple comparisons test; Fig. 31c). However, no difference in academic scores among NT, and ET ($P > 0.05$; Tukey's multiple comparisons test; Fig. 31d).

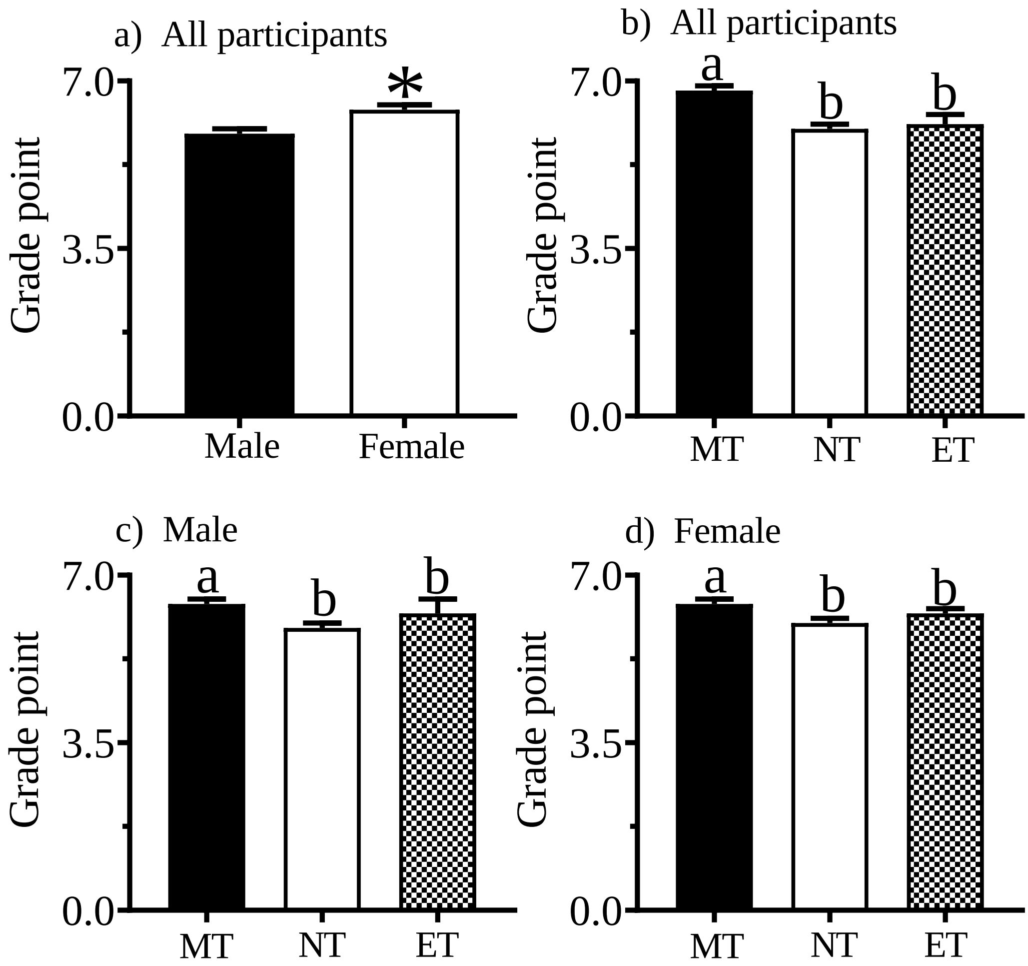

Figure 31: Data is represented as mean ± SE. Comparison of grade points among the overall participants of school and university students. (a) Gender basis (b) Based on chronotype (c) Male participants based on chronotype (d) Female participants based on chronotype. '*' sign indicates significant difference between males and females (a). Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes (b-d).

Comparison of academic scores achieved between school and university students also showed significant differences, and university students scored higher academic grades than school students ($P < 0.0001$; Unpaired t-test; Fig. 32a). Gender basis comparison between school and university students suggests that irrespective of gender, university students had a better score than school students (Male: $P < 0.0001$; Unpaired t-test; Fig. 32b; Female: $P < 0.0001$; Unpaired t-test; Fig. 32c). Chronotype-based analysis also suggests that irrespective of chronotype, university students had better academic scores (MT: $P < 0.0001$; Unpaired t-test; Fig. 32d; NT: $P < 0.0001$; Unpaired t-test; Fig. 32e; ET: $P < 0.0001$; Unpaired t-test; Fig. 32f).

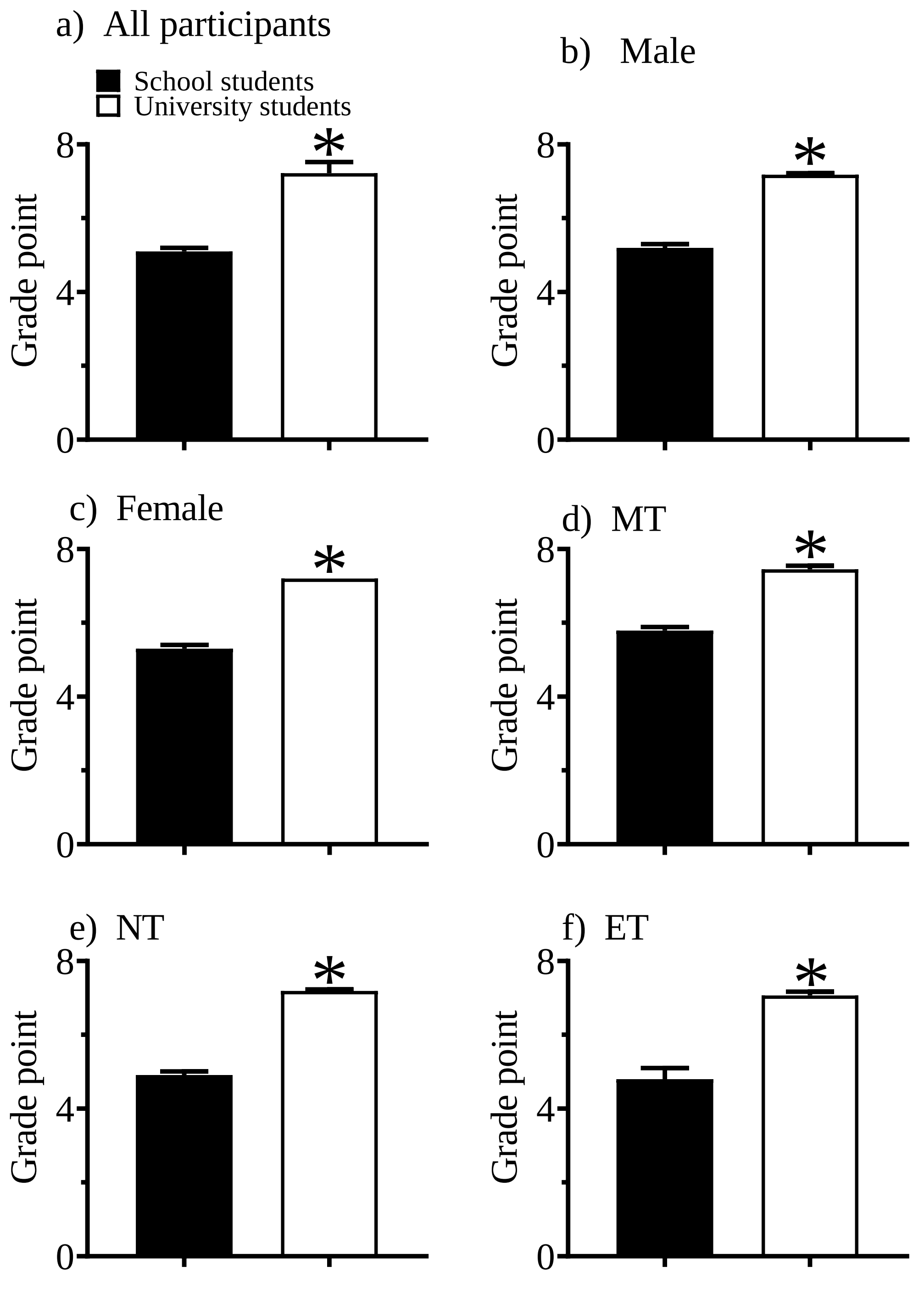

Figure 32: Data is represented as mean ± SE. Comparison of grade points between school and university students. '*' sign indicates significant difference between school and university students.

Among school students, effect of gender on achievement of academic scores were observed ($P = 0.0306$; Unpaired t-test; Fig. 33a), and females achieved higher grade points than males ($P = 0.0306$; Unpaired t-test; Fig. 33a). Chronotype-based comparison of grade points showed effect of chronotype on academic scores ($F_{2,424} = 11.69$, $P < 0.0001$; One way ANOVA; Fig. 33b). MT school students had achieved higher academic score than NT, and ET ($P < 0.05$; Tukey's multiple comparisons test; Fig. 33b). Chronotype based comparison of grade points among male school students showed effect of chronotype on academic achievement ($F_{2,202} = 8.300$, $P = 0.0003$; One way ANOVA; Fig. 33c). MT male students showed better academic scores than NT, and ET ($P < 0.05$; Tukey's multiple comparisons test; Fig. 33c). However, no differences in academic scores were observed between NT and ET participants ($P > 0.05$; Tukey's multiple comparisons tests; Fig. 33c). Female school students had similar responses ($F_{2,278} = 5.382$, $P = 0.0051$; One way ANOVA; Fig. 33d). MT female participants had better academic achievements than NT and ET ($P < 0.05$; Tukey's multiple comparisons test; Fig. 33d). However, no differences in academic scores were observed between NT and ET participants ($P > 0.05$; Tukey's multiple comparisons test; Fig. 33d). Chronotype and gender-based comparison of grade points among school students showed that effect of gender was not reflected in academic achievements between male and female MT participants, and there was no difference between the academic achievements of males and females ($P = 0.7858$; Unpaired t-test; Fig. 33e). However, females had better academic achievements than males among both NT ($P = 0.0234$; Unpaired t-test; Fig. 33f), and ET participants ($P < 0.0001$; Unpaired t-test; Fig. 33g).

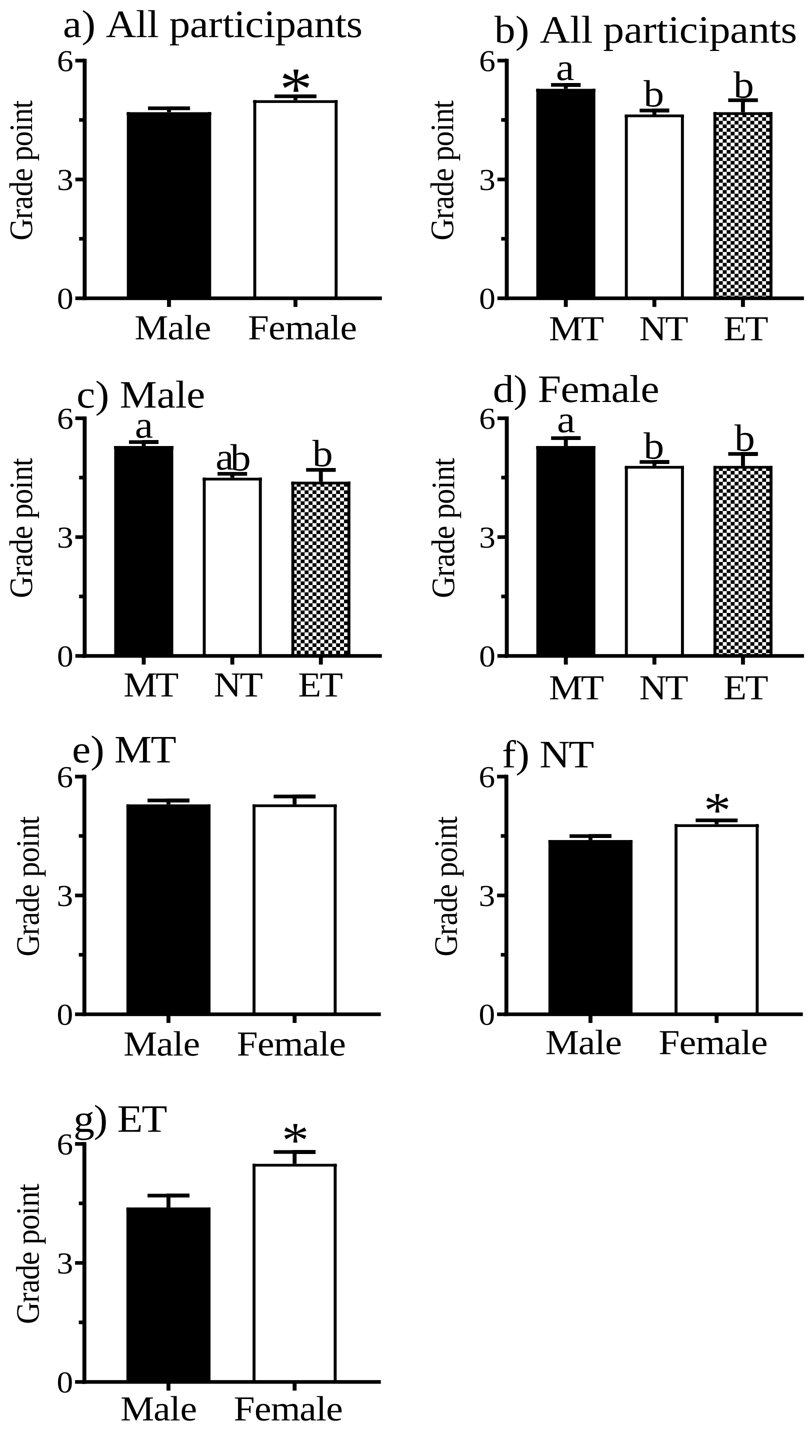

Figure 33: Data is represented as mean ± SE. Comparison of grade points among school students. (a) Gender basis (b) Based on chronotype (c) Male participants based on chronotype (d) Female participants based on chronotype (e) MT gender basis (f) NT gender basis (g) ET gender basis. '*' sign indicates significant difference between males and females (a,f,g). Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes (b-d).

In case of university students, academic scores achieved were significantly different between male and female participants (P = 0.0367; Unpaired t-test; Fig. 34a) and females had higher grade points than male participants (P = 0.0367; Unpaired t-test; Fig. 34a). Effect of chronotype is also reflected on academic scores ($F_{2,434}$ = 5.507, P = 0.0043; One way ANOVA; Fig. 34b). Better academic performances were observed among MT, than NT and ET (P < 0.05; Tukey’s multiple comparisons test; Fig. 34b). However, no difference between ET and NT was observed (P > 0.05; Tukey’s multiple comparisons test; Fig. 34b). Comparison of grade points among male reflects effect of chronotype on academic scores achieved ($F_{2,263}$ = 10.02, P < 0.0001; One way ANOVA; Fig. 34c). Among the three chronotypes, highest academic scores were achieved by MT, followed by NT, while ET had lowest academic scores (P < 0.05; Tukey’s multiple comparisons test; Fig. 34c). Academic scores among females were different than males ($F_{2,479}$ = 5.352, P = 0.0050; One way ANOVA; Fig. 34d). MT female participants had significantly higher academic scores than ET (P < 0.05; Tukey’s multiple comparisons test; Fig. 34d). However, no difference in academic scores of MT and NT, and NT and ET were observed (P > 0.05; Tukey’s multiple comparisons tests; Fig. 34d). Chronotype and gender-based comparison of grade points among university students showed no differences in academic achievements, except for ET between male and female participants (MT: P = 0.5644; Unpaired t-test; Fig. 34e; NT: P = 0.3578; Unpaired t-test; Fig. 34f). Females had higher grade points than males among ET (P = 0.0058; Unpaired t-test; Fig. 34g).

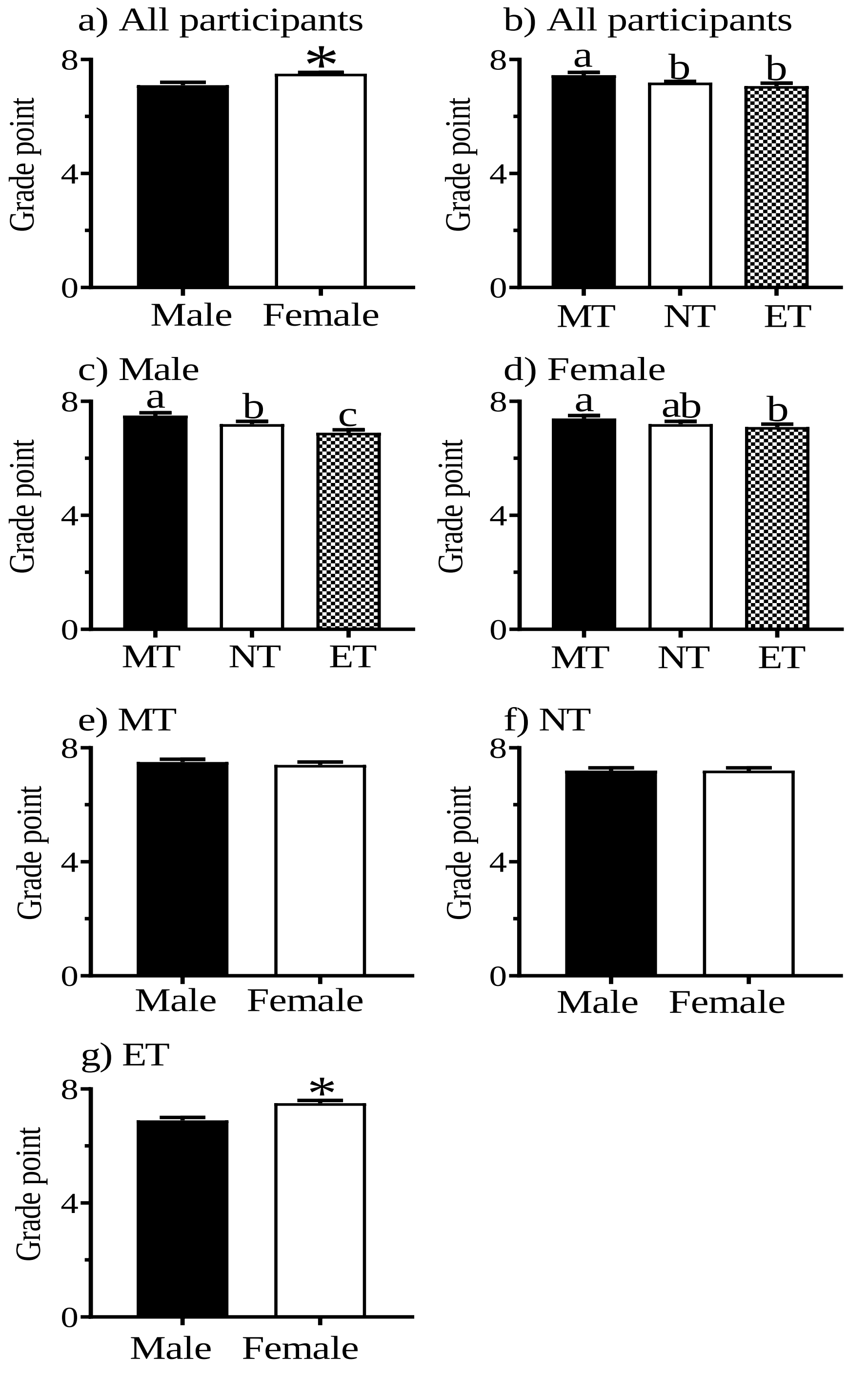

Figure 34: Data is represented as mean ± SE. Comparison of grade points among university students. (a) Gender basis (b) Based on chronotype (c) Male participants based on chronotype (d) Female participants based on chronotype (e) MT gender basis (f) NT gender basis (g) ET gender basis. '*' sign indicates significant difference between males and females (a,f,g). Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes (b-d).

DISCUSSION

Despite being school or university students, NT and ET participants consistently received poorer marks (Fig. 31, 33, 34). These findings are in line with other research that reported a chronotype link with academic success (Borisenkov et al., 2010; Cohen-Zion and Shiloh, 2017; Escribano et al., 2012; Preckel et al., 2013; van der Vinne et al., 2015; Vollmer et al., 2013). Furthermore, in earlier sections, we have shown that the ET participants had worse sleep pattern, and higher levels of daytime sleepiness (Fig. 3,4,5). In contrast to examination schedules during the day, late chronotype students have a tendency to stay active later and sleep later at night, which leads to increased daytime sleepiness and low alertness levels in the morning (van der Vinne et al., 2015). The exam schedule may be one of the factors contributing to the low academic achievement of ET students. All educational institutions have a similar morning schedule when exams are given. MT chronotype performs better in the morning, whereas the late chronotype performs better in the evening (Goldstein et al., 2007; Lara et al., 2014). The fact that the exams were given in the morning when NT and ET students' cognitive powers were not at their peak may have contributed to their subpar exam results. Our results from both school and university students are comparable with a study analyzing the influence of chronotype on academic success in Italian university students, which suggests that MT earns higher marks than NT or ET (Montaruli et al., 2019).

Sleep is crucial in learning and memory consolidation (Yang et al., 2014; Bruin et al., 2017). Some scientific research has linked lack of sleep to poor academic performance (Zhao et al., 2019; Alotaibi et al., 2020). Irregular sleep patterns and poor sleep habits might also contribute to subpar performance in the exams conducted during morning hours. A regular sleep/wake cycle, a comfortable setting, avoiding stimulating activities just before bed, and minimizing technology usage in or before bed are all healthy sleep hygiene. The study found that female participants generally had better grade point averages than male participants (Fig. 31a,33a,f,g,34a,g), both school and university students (Fig. 31,33,34). This conclusion aligns with other previous research on adolescents (Voyer and Voyer, 2014; Britner, 2008; Duckworth and Seligman, 2006; Goetz et al., 2008; Pomerantz et al., 2002), which also found that female students outperformed male students in school.

Interestingly, female students are more concerned with pleasing adults, and they also emphasize the preparation of their academic evaluations than male students (Pomerantz et al., 2002). Further, studies suggested that female students outperform male students partly because they are more self-disciplined (Duckworth and Seligman, 2006). Along with cognition and effect, motivation can also impact academic performance. Students' academic performance is improved by their increased desire to learn. Vital intellectual goals, however, may result in severe sleep deprivation. The results of research on high school students in Iran that took into account chronotype, sexual characteristics, conscientiousness, also assessment of anxiety using grade point average (GPA), since the academic accomplishment result revealed that male and female participants' GPAs varied, with females scoring higher and males scoring lower. The study also demonstrates a clear link between conscientiousness, GPA, and morningness, respectively, indicating that gender is a crucial predictor of academic accomplishment (Rahafar et al., 2015).

In studies examining the association between chronotype and academic accomplishment, the period of time, when the participants were tested, has typically not been considered. MT individuals are accommodated more than those with evening chronotype because they are generally assessed with a similar typical educational program (by periods and assessments held early during the day). To meet ET students' preferences in their study habits, studies examined the academic outcomes when courses and/or assessments were scheduled later in the day (Enright and Refinetti, 2017; Beşoluk et al., 2011). Despite these initiatives, ET students' academic performance lagged behind MT students (Beşoluk et al., 2011; Enright and Refinetti, 2017). This is probably because ET has trouble catching up on sleep when exam periods are set early in the morning or late at night. The lack of interest, attention, and attendance that ET children experience during the day makes it difficult for them to learn.

Additional investigation is required to define whether the perceived academic advantage of the morning chronotype still exists once the period of time that lessons and assessments held is considered. The perceived academic advantage of the morning chronotype may be described by this characteristic preference. Internal time may ultimately have a significant role in this illness. It's possible that students who attend classes and take examinations in the evening will fare equally well as students who attend lessons and take assessments during the morning period. Recently, this presumption has drawn specific consideration. Three studies with high school pupils (Beşoluk et al., 2011; Itzek-Greulich et al., 2016; van der Vinne et al., 2015) made an effort to separate internal time from external time. Sadly, these results did not have the best experimental plans. In two of these three studies (Beşoluk et al., 2011) and (Itzek-Greulich et al., 2016), groups of students attended classes at two different times of the day but were tested at the same time. During two different periods of the day, students' performance was tested, however, attended classes simultaneously in the third study (van der Vinne et al., 2015). A competent investigation must give students tests at times that correspond to the time of day they are studying since the discrepancy among internal or external may impair either the skill of learning or assessment or together.

Teenagers and their parents must be alert to the genuine outcome of deprived sleep patterns. More research may be needed to determine the relationship between motivation to study, skip sleep, and actual academic achievement. The current study has a drawback. Fundamental associations were not considered since it was a cross-sectional study. Further study is required to define if the intervention improves sleep disorders in sleep hygiene. It is crucial to know that cross-sectional research may only demonstrate associations, not causality, for which longitudinal investigations would be conducted in a subsequent study. For future work affiliation and health, academic achievement is an essential marker. Forthcoming research should survey the connection between sleep patterns and the influence of school on educational status.

SECTION 7. STUDY OF FOOD ADDICTION, CHRONOTYPE, DEPRESSION LEVEL AND SLEEP QUALITY AMONG SCHOOL, UNIVERSITY STUDENTS, AND WORKING ADULTS

ABSTRACT

Food addiction (FA) is a common disorder in overweight/obese individuals and is increasingly common in young people. It is essential to understand the behavioral issues related to eating as it offers a significant understanding of the increase in obesity and, then the prevention methods of its existence or treating strategies. Obesity is a lifestyle disease, and its prevalence is increasing in society. It has a complex, multifactorial origin and is related to more significant diseases, and can even cause death among individuals. Chronotype define a person's preferred time of the day for the activity-rest cycle, and they are categorized into morning type (MT), neither type (NT), and evening type (ET). The association between chronotype and general health research is increasing. This study aimed to identify food addiction (FA), depression level, and sleep patterns among school students, and compared it with university students, and working adults. The study included 607 school students, 342 university students, and 285 working adults. The study was conducted by using Morningness-Eveningness Questionnaire (MEQ), Pittsburgh's Sleep Quality Index (PSQI), Zung Self-Rating Depression Scale (SDS), and Yale Food Addiction Scale (YFAS). The highest chronotype percentage was observed among NT, followed by MT and ET in the overall participants, school students, and working adults. In the case of university students, the highest percentage of chronotype was identified in NT, whereas the percentage of ET was slightly higher than in MT. The percentage of food addiction (FA) was determined to be highest among university students than among working adults and school students. The lowest self-rating depression level was observed among working adults. However, poor sleep quality was found among university students. To correlate FA with the other parameters, Pearson Correlation Coefficient was used. A positive correlation was identified between FA with depression level, and sleep quality.

INTRODUCTION

Obesity is pervasive in different countries, regardless of economic status (Fleming et al., 2014). There are a number of physiological (internal) and environmental (external) factors that increase the risk of obesity. The influence of environmental or external features, such as the accessibility of inexpensive, high-caloric nutrients (the "obesogenic environment"; Corsica and Hood, 2011) may be the source of obesity. One of the internal risk factors that can result in obesity is food addiction (FA; Volkow and Wise, 2005). The premise behind the idea of FA is that particular foods, such as those that are rich in energy (Pursey et al., 2015), fat, high in sugar (Ayaz et al., 2018), extremely appealing (Gearhardt et al., 2011), and highly processed food (Schulte et al., 2015) can change an individual's eating habits. People with FA cannot control their food intake and continue to consume these foods despite the detrimental effects on their physical or mental health (Gold et al., 2003). According to studies and reports, people who are overweight or obese and those who participate in emotional eating are more likely to report FA (Gearhardt et al., 2012; Gearhardt et al., 2013; Gearhardt et al., 2014). The risk of FA varies in different categories among the individual as a result of the diverse sociocultural burdens of the obesogenic environment. Depending on the age, other fundamental processes of the association of FA and excessive body weight may apply. It has previously been demonstrated that the FA detection rate increases significantly in 17-18-year-old teenagers and peaks in people between the ages of 19-20 years (Borisenkov et al., 2020). Significant increases in academic strain brought on by final test preparation and lifestyle differences brought on by the start of life separately from their relatives are two possible explanations for these changes in eating habits. Students may develop eating disorders such as dietary constraints and binge eating due to increased workload, pressure for performance, separation from family, and post-school plans (Quick and Byrd-Bredbenner, 2013; Beiter et al., 2015; Farrer et al., 2016). There are certain key features of mental and emotional activity and its source of energy. First off, mental activity is an energy-intensive method. The brain weighs 2.0% of the body yet uses 20.0% of the energy available while the body is at rest (Müller and Geisler, 2017). Second, according to studies, glucose is the primary fuel for brain activity (Benton et al., 1996). Certain features of the eating behavior of FA cover the mental activity and avialibity of energy. Recent studies indicates that people with FA typically eat high-energy diets that are fatty and carbohydrate-rich (Pursey et al., 2015; Schulte et al., 2015; Burrows et al., 2017). Impaired executive function is demonstrated by obese children, having poor memory and shortened problem-solving skills, response inhibition, elastic mind, and design capacity. It is known that obesity in people is connected with suppressed cognitive performance (Smith et al., 2011).

Research proves that higher symptom scores on YFAS tools are associated with increased craving and consumption of processed and convenience foods (Gearhardt et al., 2014; Pursey et al., 2015; Pursey et al., 2017), higher impulsivity (Murphy et al., 2014; Beaton et al., 2014; Meule et al., 2017), elevated body mass index (BMI) and more frequent binge eating (Grilo, 2015; Wolz et al., 2017). Higher scores on the YFAS are also associated with genetic profiles implicated in reward dysfunction (Davis et al., 2013; Pedram et al., 2017) and neurophysiological correlation, similar to substance-related addictive disorders (Imperatori et al., 2015) and are less correlated with smoking, drinking, and other drug use (Davis et al., 2011; Clark and Saules, 2013). A wide range of FA symptoms can occur and are related not only to certain foods but also to the behaviors of intake; besides, obesity can occur independently.

FA has been detected in healthy weight and non-clinical populations (Pursey et al., 2014). According to studies late chronotype, poor sleep quality, and FA are closely associated (Kandeger et al., 2019; Najem et al., 2019). Several studies have shown that sleeping patterns affect body weight and eating behaviors. The main sleep characteristics associated with weight and eating patterns are short duration of sleep and deprived sleep quality. The circadian rhythm controls eating and sleeping patterns (Kandeger et al., 2018). The chronotype is inherently linked to well-being and may be associated with disordered eating (Kivela et al., 2018). It represents inter-individual variability in day-to-day activity patterns and sleep/wake cycles. The circadian rhythm, also referred to as the biological clock, categorizes each person's chronotype into one of three categories (morning, neither, or evening type), which vary depending on a series of psychological, behavioral, and biological factors like performance, mood, alertness, and appetite. The disparity between chronotype groups significantly impacts sleep and sleep patterns (Adan et al., 2012; Song et al., 2018). According to earlier research, eveningness has been linked to depressive disorders, bad lifestyle choices, and a known susceptibility to addiction. In addition, irregular circadian rhythms are linked to obesity, diabetes, heart disease, and cancer (Foster and Roenneberg, 2008).

Numerous studies have observed a strong association between FA and depression (Burmeister et al., 2013; Meadows et al., 2017; Borisenkov et al., 2018; Burrows et al., 2018). Gearhardt et al., (2011b) found relationships between FA and higher depression level, poorer emotion regulation, lower self-esteem, and a higher prevalence of mood disorders. Assessing emotional condition along with FA could deliver an understanding of the overlying structures of psychological well-being with eating addiction. According to longitudinal research of a sizable sample of adults, an increase in stress-related eating was associated with sleep deprivation (Chaput et al., 2011), leading to an increase in stress-related eating (Bond et al., 2001). Previous studies have pointed out that stress is an important cause of the development of addictive behaviors and the inability to quit such behaviors (Hardy et al., 2018; Mitchell and Wolf, 2016). The degree of mental and social stress experienced by individuals and the number of stressors in life are highly correlated with overeating and unhealthy eating habits, such as a low intake of vegetables and an increased intake of high-calorie foods (Mitchell and Wolf, 2016; Errisuriz et al., 2016; Neseliler et al., 2017). Stress has been identified as a response to an event or an ongoing sense of fear (Neseliler et al., 2017). Therefore, the degree of perceived stress is a highly adapted feeling that differs among persons depending on individual vulnerability and resilience (Folkman and Lazarus, 1984).

The frequency of obesity is growing, that reflects various features, including the easy availability of highly delicious foods, and consequently increases the sales of food manufacturing industry. Due to all these factors, the concept of FA becomes more extensive. This study aimed to identify and correlate FA with sleep quality and depression levels in school students and compare it with university students and working adults.

MATERIALS AND METHODS

The study involved total 1234 participants, 607 school students (307 male and 300 female), 342 university students (154 male and 188 female), and 285 working adults (133 male and 152 female). The age group of volunteers from school students ranged between 14 to 20 years (16.9±0.1 years), while among university students, the age group ranged from 20 to 30 years (23.1±0.2 years), and in the case of working adults, the age group ranged between 25 to 60 years (33.8±0.8 years). The aim and objectives of the study were informed to all volunteers, and consent was obtained. The study included using of Morningness-Eveningness Questionnaire (MEQ), Pittsburgh's Sleep Quality Index (PSQI), Zung Self-Rating Depression Scale (SDS), and Yale Food Addiction Scale (YFAS) created by Gearhardt et al., (2009).

Statistical analysis

Student t-test was used to analyze the differences when comparing two point values. One-way ANOVA, followed by Tukey's multiple comparison test, was performed to determine the differences between the three groups. Significance was taken at $P < 0.05$. Pearson correlation coefficient was used to analyze the correlation of FA with the other parameters.

RESULTS

The percentage of different types of chronotypes among all participants is presented in figure 35a. NT participants dominated the population and had the highest percentage (65.4%), followed by MT (24.5%), while only 9.9% were reported as ET (Fig. 35a). Similarly, NT participants were highest (67.0%) among schools, university students (57%), and working adults (68.2%). 26.5% among school students and 20.0% among working adults reported as MT, while 6.4% of school students, 23.9% of university students, and 11.7% of working adults were reported as ET (Fig. 35b,c,d).

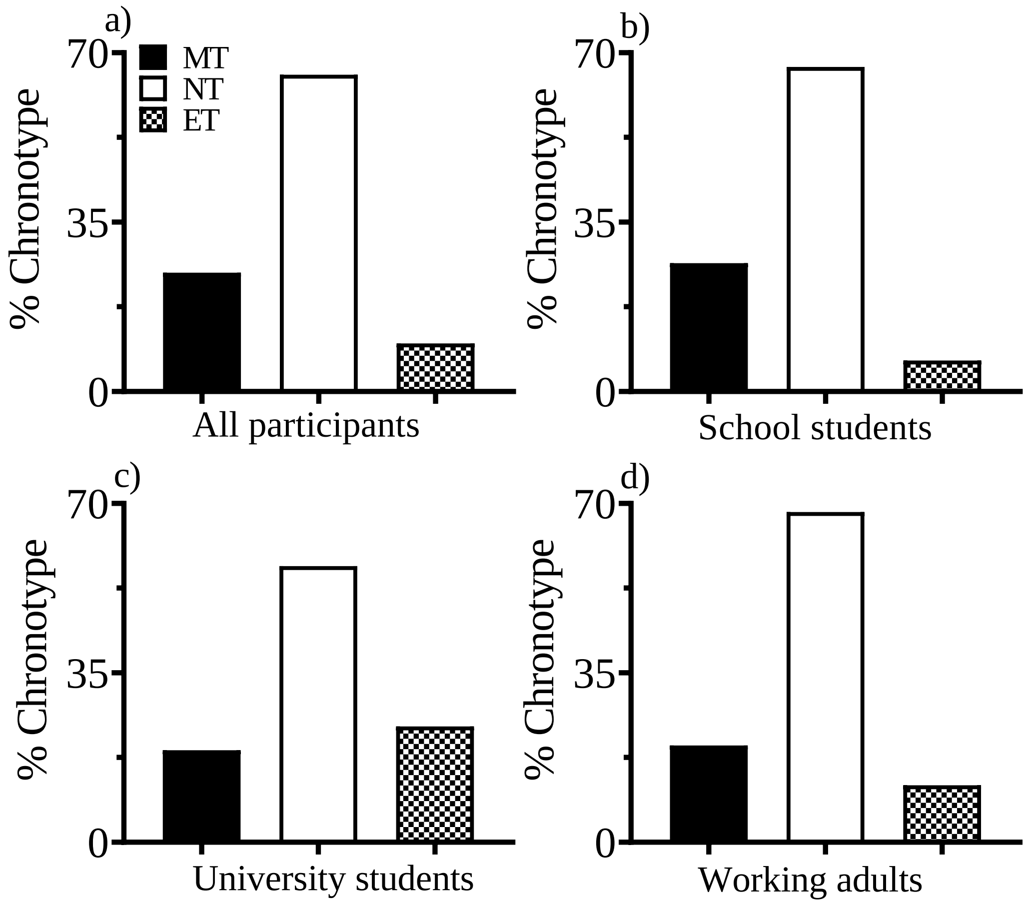

Figure 35: Data is represented as percentage. Percentage of chronotype among school students, university students, and working adults.

Figure 36a represents the percentage of FA among school students, university students, and working adults. Among the three study groups, the highest FA (47.1%) was observed among university students, followed by working adults (27.0%). In contrast, only 15.3% of school students were identified as FA (Fig. 36a). When gender-wise comparison was analyzed, 25.5% of females and 19.0% of males were identified as FA (Fig. 36b).

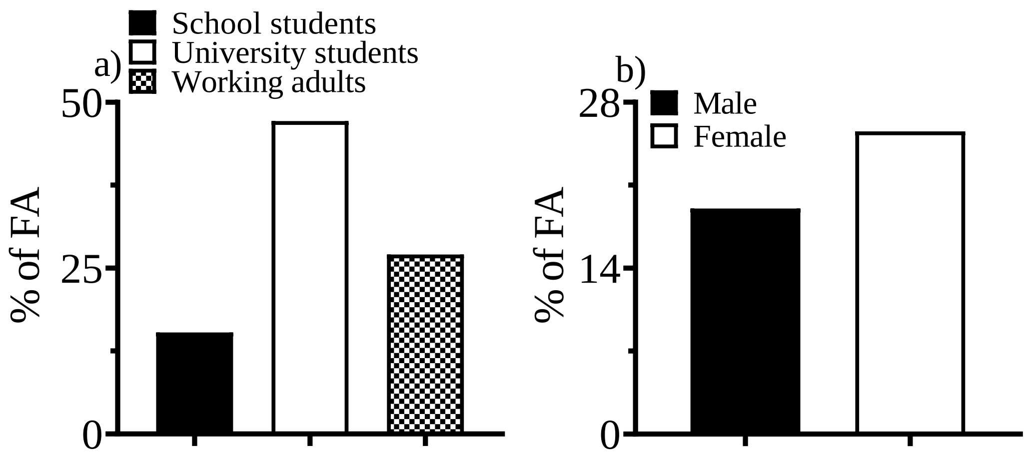

Figure 36: Data is represented as percentage. (a) Total percentage of FA among school students, university students, and working adults and, (b) total male and female.

Chronotype-based FA analysis suggests that the highest FA was observed in ET participants, followed by NT among school students (16.2%) and working adults (25.8%; Fig. 37a,c). The lowest FA was observed in MT participants, both in school students (9.9%) and working adults (17.6%; Fig. 37a,c). However, among university students, MT participants (51.8%) had higher FA than NT (40.7%; Fig. 37b).

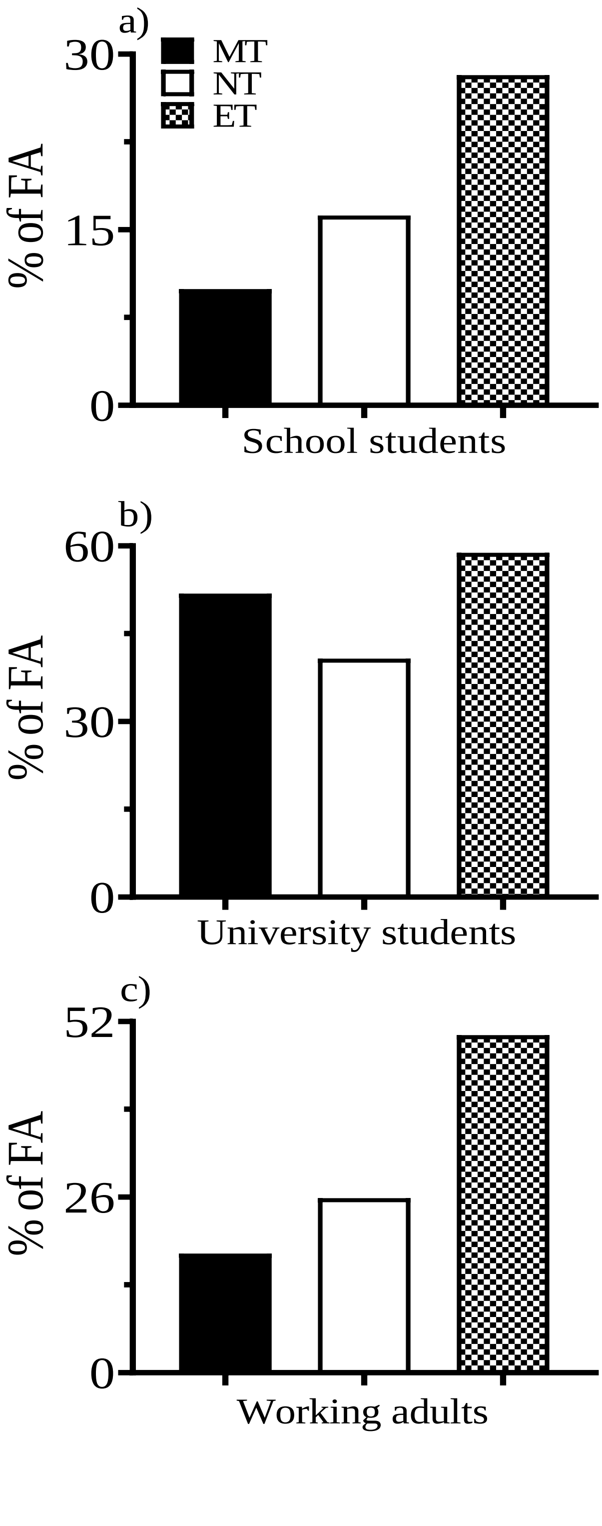

Figure 37: Data is represented as percentage. Total percentage of FA between MT, NT and ET of school students, university students, and working adults.

Chronotype-based comparison of SDS scores showed the difference among the three chronotypes ($F_{2,831}$ = 8.994, P = 0.0001; One way ANOVA; Fig. 38). MT participants had significantly lower SDS scores than NT and ET ($P < 0.05$; Tukey's multiple comparisons test; Fig. 38).

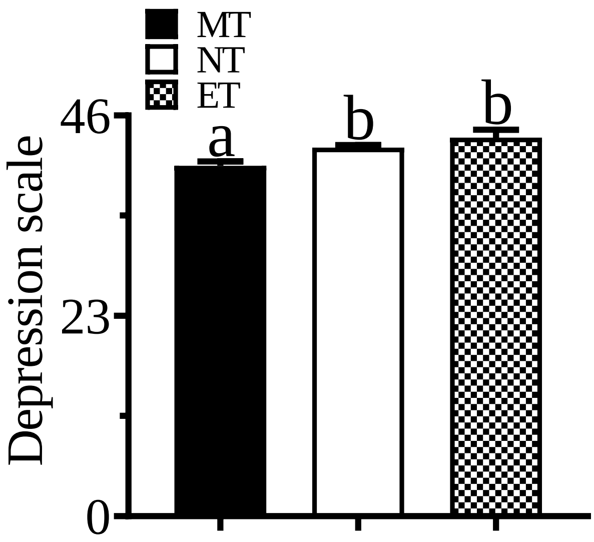

Figure 38: Data is represented as mean ± SE. Comparison of SDS scores between MT, NT and ET of school students, university students, and working adults. Similar alphabets show no difference while different alphabets show significant difference among the three chronotypes.

Gender-wise comparison of the self-rating depression level is shown in figure 39. Significantly higher self-rating depression levels was reported among female participants ($P < 0.0001$; Unpaired t-test; Fig. 39).

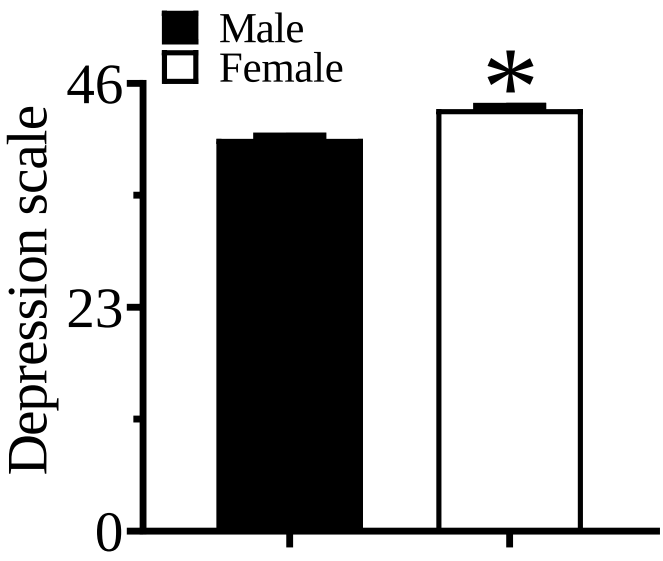

Figure 39: Data is represented as mean ± SE. Comparison of SDS between males and females among school students, university students, and working adults. '*' sign indicates significant difference between males and females.

The overall self-rating depression level was compared between the three study groups, and significant differences were observed ($F_{2,831}$ = 15.53, P < 0.0001; One way ANOVA; Fig. 40a). The self-rating depression level was lowest (P < 0.05; Tukey's multiple comparisons test; Fig. 40a) among working adults. However, no differences in the depression levels were observed between school and university students (P > 0.05; Tukey's multiple comparisons test; Fig. 40a). Chronotype-based analysis showed that among MT, the lowest depression score was observed in working adults, followed by school students, while highest depression scale was observed in university students ($F_{2,202}$ = 17.22, P < 0.0001; One way ANOVA; Fig. 40b). NT participants also had differences ($F_{2,502}$ = 16.97, P < 0.0001; One way ANOVA; Fig. 40c), and working adults had a significantly lower score than school and university (P < 0.05; Tukey's multiple comparisons test; Fig. 40c). However, we do not see differences among ET ($F_{2,80}$ = 0.4693, P = 0.6272; One way ANOVA; Fig. 40d). Correlation of FA with Zung Self-Rating Depression Scale (SDS) of the overall participants was analyzed. A positive correlation was observed between YFAS and SDS score (*r* = 0.1473; P = 0.0472; Pearson Correlation Coefficient).

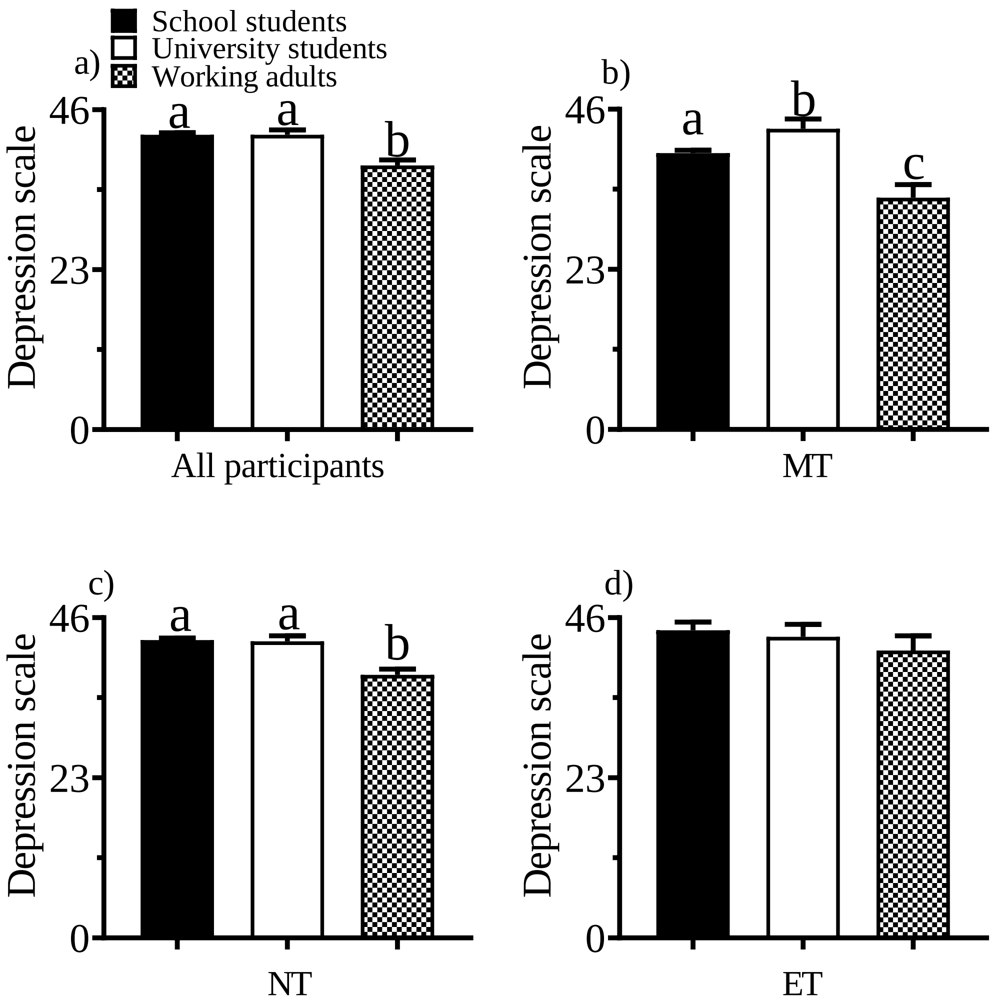

Figure 40: Data is represented as mean ± SE. (a) Comparison of SDS between school students, university students, and working adults, (b) Comparison of SDS scores based on chronotype. Similar alphabets show no difference while different alphabets show significant difference among the three groups.

The global PSQI score and the different sleep habits of PSQI were compared among the three studied groups. The global PSQI score was lowest in school students ($F_{2,831}$ = 6.674, P = 0.0013; One way ANOVA; Fig. 41a) than in university students and working adults. However, no difference in global PSQI score was observed between university students and working adults (P > 0.05; Tukey's multiple comparisons tests; Fig. 41a). Significant differences were observed between the three groups in different sleep parameters:- bed-time ($F_{2,831}$ = 15.60, P < 0.0001; One way ANOVA; Fig. 41b), get-up time ($F_{2,831}$ = 75.47, P < 0.0001; One way ANOVA; Fig. 41c), a score of sleep quality ($F_{2,820}$ = 3.994, P = 0.0188; One way ANOVA; Fig. 41d), sleep latency ($F_{2,823}$ = 4.347, P = 0.0132; One way ANOVA; Fig. 41e), sleep duration ($F_{2,823}$ = 3.517, P = 0.0302; One way ANOVA; Fig. 41f), sleep efficiency ($F_{2,831}$ = 27.71, P < 0.0001; One way ANOVA; Fig. 41g), sleep medication ($F_{2,831}$ = 40.71, P < 0.0001; One way ANOVA; Fig. 41i), and daytime dysfunction ($F_{2,831}$ = 6.633, P < 0.0001; One way ANOVA; Fig. 41j). Bed-time and get-up time, was significantly earlier in school students than university students and working adults (P < 0.05; Tukey's multiple comparisons tests; Fig. 41b,c). However, no differences between university students and working adults were observed (P > 0.05; Tukey's multiple comparisons tests; Fig. 41b,c). Sleep quality and sleep duration scores were significantly higher in university students than in school students and working adults (P < 0.05; Tukey's multiple comparisons test; Fig. 41d,f). However, no difference between school students and working adults was observed (P > 0.05; Tukey's multiple comparisons test; Fig. 41d,f). Sleep latency and sleep efficiency scores were significantly less in school students than in university students and working adults (P < 0.05; Tukey's multiple comparisons test; Fig. 41e,g). However, no differences between school students and university students were observed in the score of sleep latency (P > 0.05; Tukey's multiple comparisons test; Fig. 41e), and there was no difference between university students and working adults in the score of sleep efficiency (P > 0.05; Tukey's multiple comparisons test; Fig. 41g). Highest sleep medication score was observed in university students followed by working adults while minimum score was observed in school students (P < 0.05; Tukey's multiple comparisons test; Fig. 41i). Daytime dysfunction score was significantly less in working adults than school and university students (P < 0.05; Tukey's multiple comparisons test; Fig. 41j). However, no differences between school and university students were observed ($P > 0.05$; Tukey's multiple comparisons test; Fig. 41j). Sleep disturbances score did not vary among the three groups ($F_{2,831} = 2.261$, $P = 0.1049$; One way ANOVA; Fig. 41h). When we correlate FA with Pittsburgh's Sleep Quality Index (PSQI), YFAS and PSQI score were positively correlated ($r = 0.3221$; $P < 0.0001$; Pearson Correlation Coefficient). A positive correlation was observed between YFAS and PSQI in all three studied groups (School students: $r = 0.2919$; $P = 0.0048$; Pearson Correlation Coefficient; University students: $r = 0.3467$; $P = 0.0041$; Pearson Correlation Coefficient; Working adults: $r = 0.2851$; $P = 0.1873$; Pearson Correlation Coefficient).

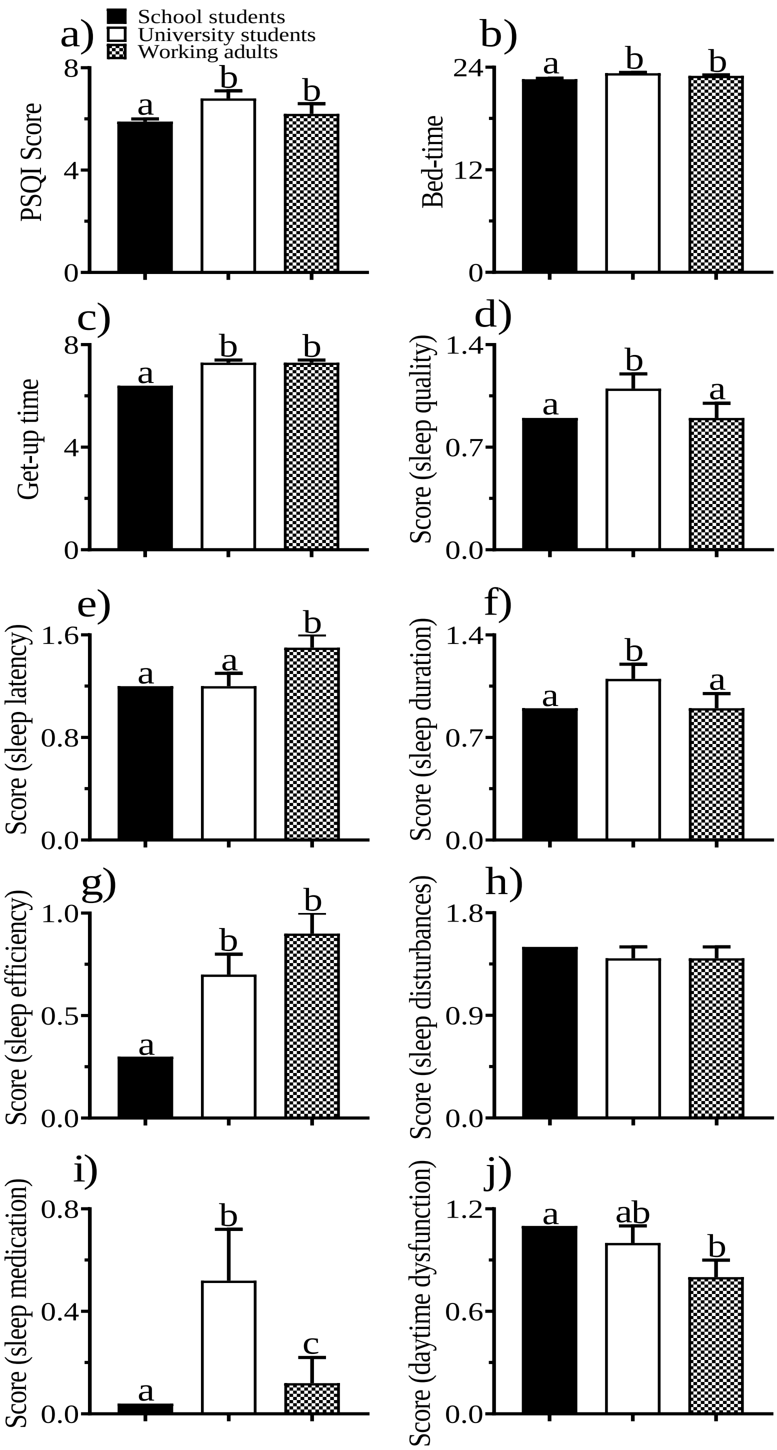

Figure 41: Data is represented as mean ± SE. Comparison of global PSQI score and different sleep habits between school students, university students , and working adults of males and females. Similar alphabets show no difference while different alphabets show significant difference among the three groups.

Figure 42 represents a comparison of the global PSQI and different sleep habits of PSQI among the three study groups based on chronotype. Among MT, significant difference was observed in the global PSQI score ($F_{2,282}$ = 10.43, P < 0.0001; One way ANOVA; Fig. 42a), get-up time ($F_{2,286}$ = 7.089, P = 0.0011; One way ANOVA; Fig. 42c), score of sleep quality ($F_{2,286}$ = 4.497, P = 0.0119; One way ANOVA; Fig. 42d), sleep latency ($F_{2,282}$ = 4.918, P = 0.0081; One way ANOVA; Fig. 42e), sleep duration ($F_{2,282}$ = 7.266, P = 0.0008; One way ANOVA; Fig. 42f), sleep efficiency ($F_{2,282}$ = 4.259, P = 0.0154; One way ANOVA; Fig. 42g), sleep disturbances ($F_{2,282}$ = 14.37, P < 0.0001; One way ANOVA; Fig. 42h), and sleep medication ($F_{2,286}$ = 14.13, P < 0.0001; One way ANOVA; Fig. 42i). Lowest global PSQI was observed in working adults, while maximum PSQI score was identified from university students, while school students show intermediate PSQI scores (P < 0.05; Tukey's multiple comparisons test; Fig. 42a). Get-up time was significantly earlier in school students than university students and working adults (P < 0.05; Tukey's multiple comparisons test; Fig. 42c). However, no differences between university students and working adults were observed (P > 0.05; Tukey's multiple comparisons test; Fig. 42c). Both sleep quality scores and sleep latency scores were significantly lower in working adults than school and university students (P < 0.05; Tukey's multiple comparisons test; Fig. 42d,e). However, no differences between these parameters were observed in school and university students (P > 0.05; Tukey's multiple comparisons tests; Fig. 42d,e). Sleep duration scores were significantly higher in university students than school students and working adults (P < 0.05; Tukey's multiple comparisons test; Fig. 42f). However, no differences were observed between school students and working adults (P > 0.05; Tukey's multiple comparisons test; Fig. 42f). Sleep efficiency score was higher in university students and working adults than school students (P < 0.05; Tukey's multiple comparisons test; Fig. 42g). Further, among MT participants, sleep disturbances scores were highest in school students, followed by university students, while minimum sleep disturbances score were observed in working adults (P < 0.05; Tukey's multiple comparisons test; Fig. 42h). Sleep medication was higher in university students than school students and working adults (P < 0.05; Tukey's multiple comparisons test; Fig. 42i). There was no difference in the bed-timing ($F_{2,202}$ = 0.3175, P = 0.7283;

One way ANOVA; Fig. 42b) and daytime dysfunction ($F_{2,202}$ = 2.042, P = 0.1325; One way ANOVA; Fig. 42j).

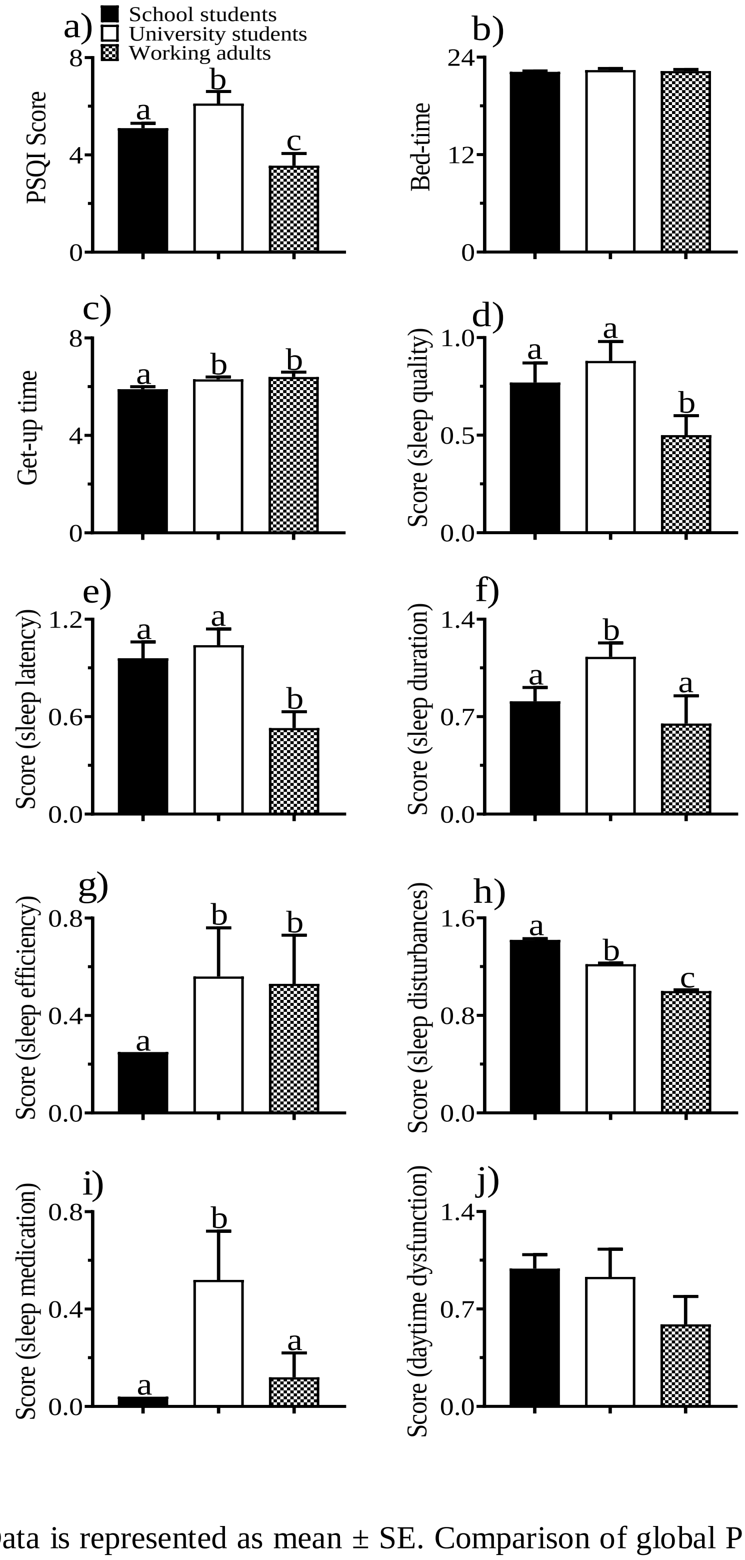

Figure 42: Data is represented as mean ± SE. Comparison of global PSQI score and different sleep habits between school students, university students, and working adults of MT. Similar alphabets show no difference while different alphabets show significant difference among the three groups.

Among NT, there was a difference in global PSQI score ($F_{2,543}$ = 3.505, P = 0.0307; One way ANOVA; Fig. 43a), and other sleep parameters: bed-time ($F_{2,543}$ = 7.412, P = 0.0007; One way ANOVA; Fig. 43b), get-up time ($F_{2,543}$ = 54.06, P < 0.0001; One way ANOVA; Fig. 43c), score of sleep latency ($F_{2,540}$ = 5.825, P = 0.0031; One way ANOVA; Fig. 43e), sleep efficiency ($F_{2,543}$ = 11.25, P < 0.0001; One way ANOVA; Fig. 43g), and sleep medication ($F_{2,543}$ = 28.78, P < 0.0001; One way ANOVA; Fig. 43i). Lower global PSQI score, earlier bed- and get-up time and lower sleep efficiency were observed among school students than university students, and working adults (P < 0.05; Tukey's multiple comparisons test; Fig. 43a,b,c,g). However, these parameters did not differ between university students and working adults (P > 0.05; Tukey's multiple comparisons test; Fig. 43a,b,c,g). Sleep latency was significantly higher in working adults than school and university students (P < 0.05; Tukey's multiple comparisons test; Fig. 43e), minimum sleep medication scores were observed among school students, followed by working adults, while maximum sleep medication scores were identified in university students (P < 0.05; Tukey's multiple comparisons test; Fig. 43i). Among NT participants, no differences were observed in the score of sleep quality ($F_{2,538}$ = 1.913, P = 0.1487; One way ANOVA; Fig. 43d), sleep duration ($F_{2,508}$ = 1.227, P = 0.2939; One way ANOVA; Fig. 43f), sleep disturbances ($F_{2,543}$ = 2.236, P = 0.1078; One way ANOVA; Fig. 43h), and daytime dysfunction ($F_{2,543}$ = 1.662, P = 0.1907; One way ANOVA; Fig. 43j).

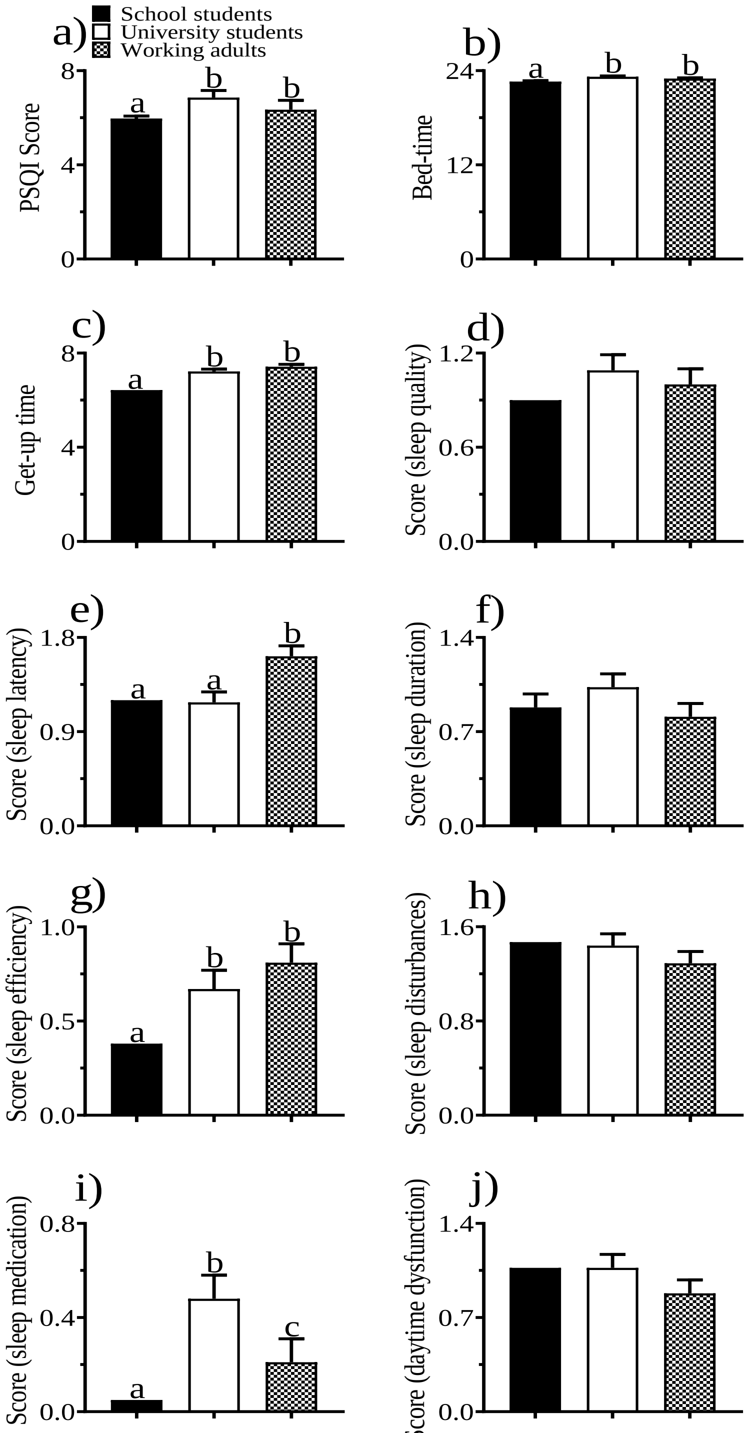

Figure 43: Data is represented as mean ± SE. Comparison of global PSQI score and different sleep habits between school students, university students, and working adults of NT. Similar alphabets show no difference while different alphabets show significant difference among the three groups.

Among ET participants, significant differences were observed in the global PSQI score ($F_{2,84}$ = 6.721, P = 0.0020; One way ANOVA; Fig. 44a), get-up time ($F_{2,80}$ = 11.61, P < 0.0001; One way ANOVA; Fig. 44c), a score of sleep quality ($F_{2,98}$ = 5.567, P = 0.0051; One way ANOVA; Fig. 44d), sleep latency ($F_{2,75}$ = 3.467, P = 0.0363; One way ANOVA; Fig. 44e), sleep efficiency ($F_{2,80}$ = 10.56, P < 0.0001; One way ANOVA; Fig. 44g), and daytime dysfunction ($F_{2,94}$ = 5.832, P = 0.0041; One way ANOVA; Fig. 44j). Global PSQI score and sleep latency scores were significantly higher in working adults than school and university students (P < 0.05; Tukey's multiple comparisons test; Fig. 44a,e). Get-up time was substantially more advanced in school students than university students and working adults (P < 0.05; Tukey's multiple comparisons test; Fig. 44c). Sleep quality score was lower among working adults than school and university students (P < 0.05; Tukey's multiple comparisons test; Fig. 44d). Sleep efficiency score was significantly less in school students than university students and working adults (P < 0.05; Tukey's multiple comparisons test; Fig. 44g). Minimum score of daytime dysfunction was observed among working adults than school and university students (P < 0.05; Tukey's multiple comparisons test; Fig. 44j). There was no difference in the bed-timing ($F_{2,80}$ = 1.053, P = 0.3537; One way ANOVA; Fig. 44b), a score of sleep duration ($F_{2,74}$ = 1.619, P = 0.2051; One way ANOVA; Fig. 44f), sleep disturbances ($F_{2,74}$ = 0.1618, P = 0.8509; One way ANOVA; Fig. 44h), and sleep medication ($F_{2,80}$ = 2.504, P = 0.0881; One way ANOVA; Fig. 44i).

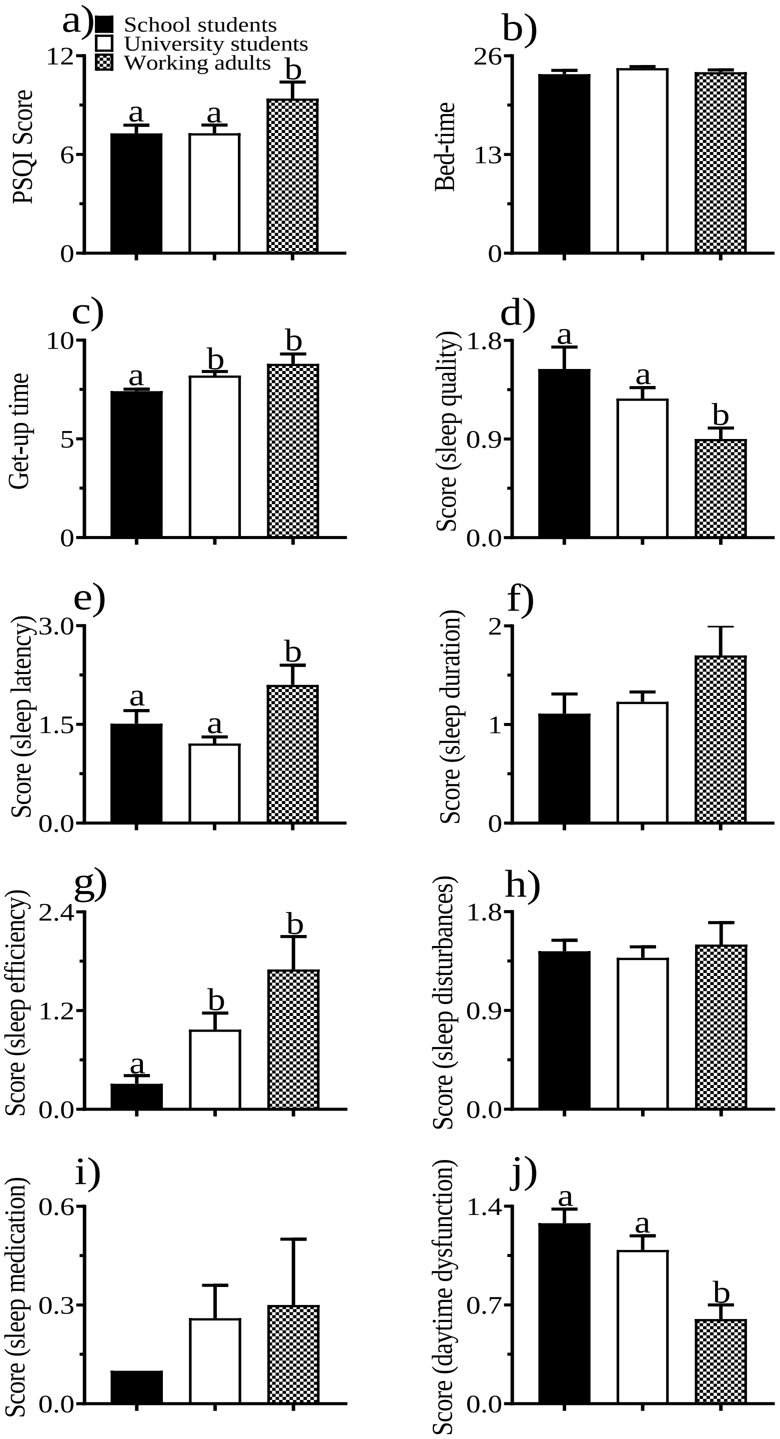

Figure 44: Data is represented as mean ± SE. Comparison of global PSQI score and different sleep habits between school students, university students, and working adults of ET. Similar alphabets show no difference while different alphabets show significant difference among the three groups.

DISCUSSION

The current study examined the levels of depression, FA, and sleep quality in three separate study groups, and the correlation coefficient was analyzed between the different parameters. When the percentage of each chronotype was analyzed, it was found that NT had the highest percentage, followed by MT and ET in all participants, as well as in students and working adults (Fig. 35a, b, d). These results are consistent with the conclusions of our previous sections. However, among university students, the percentage of ET was somewhat higher than the percentage of MT (Fig. 35c). Previous research confirms that most adolescents fall into the NT category. The second most frequent was MT, while ET was the least frequent. A study that measured morningness-eveningness using a variety of methodologies found that Italian adolescents have a higher prevalence of MT (Giannotti et al., 2002). A near-Gaussian distribution was observed by another study (Roenneberg et al., 2007), while a third study (Natale and Cicogna, 2002) claimed that 60.0-70.0% of the population is of the NT. However, there is a shift in chronotype towards eveningness near the conclusion of adolescence (Roenneberg and Merrow, 2007).

Our study suggests university students had the highest percentage of FA, followed by working adults. School students had the lowest percentage of FA (Fig. 36a). Only 8.7% of the total 1234 participants met the YFAS-defined clinical level of FA, which is less than what was found in recent meta-analyses that combined studies with samples that were primarily from the United States and found rates ranging from 16.2% to 19.9% (Burrows et al., 2018; Pursey et al., 2014). Regardless of the general misconception that eating pattern disordered is commonly less in Asian nations, the latest research showed that disparities in eating behaviors, dieting, weight, and figure concerns compared to Western states are eroding. This is said to be partially caused by the industrialization and globalization of Asian nations (Pike and Dunne, 2015). Additionally, female participants have a higher percentage of FA in the gender-based comparison (Fig. 36b), which is consistent with earlier studies of the YFAS (Pursey et al., 2014). However, females classified as having FA reported more symptoms on the YFAS. According to previous studies, females experienced more perceived stress than males (Harding et al., 2014; Raymond et al., 2017), and they also have a higher incidence of FA (Sengor and Gezer, 2019) or eating disorders (Burrows et al., 2017). However, additional research showed that while females significantly outperformed males regarding adverse mental health (particularly anxiety and stress), eating behavior, and also the symptoms of FA, the gender difference persisted for only the dynamic intake rather than the symptom counts of FA. This led the authors of that study (Raymond et al., 2017) to conclude that emotional eating behaviors, as opposed to clinical addiction signs like disordered eating behaviors, represent a true sex difference. According to Volkow et al., (2011), females with FA use high-sugar/high-fat diets as sources of stimulation to alleviate their emotional burden. Being overweight has previously been linked to a number of adverse effects, including depression (Barnes et al., 2015). Additionally, eating excessive food to cope with anxiety and sadness is possible (Yau and Potenza, 2013). These foods tend to be comfort foods (Andersen et al., 2010; Boutelle et al., 2010). Numerous studies have shown that FA has a beneficial relationship with various mental disorders, specifically with eating disorders like anorexia, bulimia, binge eating disorder, anxiety, and depression (Burrows et al., 2018).

The correlation between eating patterns and chronotype, sleep quality, and stress was another exciting study. In a prior study, morningness and dietary constraints were positively correlated (Schubert and Randler, 2008). Corresponding to other practices of addictions, the present study investigating FA showed a positive correlation between FA and sleep quality among the overall participants as well as among school, university students, and working adults. There was also a positive correlation between FA and self-rating depression levels among the overall participants. These results highlight the vulnerability of FA in spite of knowing the negative consequences of food overconsumption.

The relationship between FA and ET people is better understood since they appear more prone than MT people to have FA (Kandeger et al., 2018). In the three studied groups, the current investigation also found that ET had the highest percentage of FA (Fig. 37). In earlier investigations, it was found that stress and YFAS scores were strongly correlated, with more stress being associated with higher YFAS scores. In the present study, a positive correlation was also identified between FA and self-rating depression. It is generally known that stress can increase hunger by raising the levels of the hormones glucocorticoids, neuropeptide Y, and insulin (Adam and Epel, 2007). Stress also impacts Dynorphin levels, which alters how rewards are processed and promotes overeating (Karkhanis et al., 2017). In studies on FA, impulsivity and emotion dysregulation were predictors of FA (Pivarunas and Conner, 2015). Additionally, it was established that FA is a significant stressor for those with type 2 diabetes (Raymond et al., 2017).

Moreover, earlier research revealed significant correlations between stress and FA, then also considerably associated with lower sleep quality. In previous studies (Greer et al., 2013; Chapman et al., 2013) examining the impact of insomnia on the need for food, it was discovered that those who reported having trouble sleeping made more food purchases the following day. Additionally, FA and poorer-quality sleep are linked to nighttime eating (Nolan and Geliebter, 2017; Li et al., 2018). In this way, the circadian rhythm regulates the sleep/wake cycles. The vulnerability to substance use and substance use disorders, including caffeine, nicotine, alcohol, and illicit drugs, is exacerbated by circadian misalignment, which increases developmental tendencies towards increased reward sensitivity and impulsivity (Pasch et al., 2012). According to cross-sectional studies conducted on adults and adolescents, a stronger trend toward eveningness is associated with increased substance use or issues (Hasler et al., 2015). It was also claimed that night eating was directly associated with ET (Nolan and Geliebter, 2016). The findings of a prior study exploring potential connections between FA and chronotype demonstrated that chronotype indirectly impacts FA over stress and sleep quality.

The present investigation is the first study to assess FA, chronotype, depressive severity, and sleep quality among university students and working people to the best of our knowledge. Even if some discoveries have already been discussed in other nations, the Indian community will benefit significantly from our findings. In conclusion, this cross-sectional study examined how eating habits and depression levels are related to sleep patterns. We collected data on depression severity, FA, chronotype, and sleep quality. University students had the largest percentage of FA, according to the results. In addition, female eating patterns and self-rating depression levels were significantly correlated. Future research should confirm the results using samples of people with various eating behaviors, like bulimia nervosa, food addiction, or binge eating disorder.

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Exam passed	Board/University	Year of Passing	Subject	Division	Percentage
HSLC	Mizoram Board of School Education	2008	General	Third	49%
HSSLC	Mizoram Board of School Education	2011	Science	Second	52%
B.Sc.	Mizoram University	2014	Zoology	First	69.67%
M.Sc.	Mizoram University	2016	Zoology	First	63.5%
M.Phil.	Mizoram University	2018	Zoology	Distinction	80%

PUBLICATIONS

1. **L Jongte**, KK Tripathi and AK Trivedi (2022). Changes associate with chronotype, sleep pattern and depression levels among school students during pandemic COVID-19 lockdown and post lockdown online classes. *Journal of Environmental Biology*, 44(3):327-334.
2. **L Jongte** and AK Trivedi (2022). Chronotype, sleep quality and academic performances among Mizo students. *Chronobiology International*, 39(3):398-408.
3. AK Trivedi, Emily V, Z Renthlei and **L Jongte** (2022). Food, not the photoperiod, entrains the circadian rhythms in the liver of Winstar albino rats. *Journal of Applied and Natural Science*, 14(2):559-565.
4. TA Tserne, MF Borisenkov, SV Popov, LA Bakutova, **L Jongte**, AK Trivedi, AA Pecherkina, OI Dorogina, EA Martinson, VI Vetosheva, DG Gubin, SV Solovieva, LA Danilova, EF Turovinina, EE Symaniuk. (2021). Food addiction and weight in students with high academic performance. *Public Health Nutrition*, 24(18):6027-6033.
5. **L Jongte** and AK Trivedi (2021). Alterations of the cardiovascular rhythms and sleep quality in esophageal cancer patients. *Biological Rhythm Research,* 52(3):484-494.
6. **L Jongte** and AK Trivedi (2018). Biological Timing and Human Health: Clock Prospective. *Science and Technology,* 6(1):13-21.

CONFERENCE/SEMINAR/WORKSHOP PARTICIPATED

International

1. The 12th Annual Convention of Association of Biotechnology and Pharmacy (ABAP) and International Conference on Biodiversity, Environment and human health: Innovations and Emerging Trends (BEHIET 2018), Mizoram University, Aizawl, November 12- 14, 2018.
2. 2nd Annual Convention of North East (India) Academy of Science and Technology (NEAST) International Seminar on Recent Advances in Science and Technology (ISRAST) (16th-18th November 2020) (Virtual).

National

1. National Symposium on Avian Biology in conjunction with annual meeting of AABI, Department of Zoology, Mizoram University, Aizawl, October 22-24, 2018.
2. National Symposium on Chronobiology: Biological Timing and Health Challenges In Conjunction with the Biennial meeting of the Indian Society for Chronobiology, Department of Zoology, Mizoram University, Aizawl, March 02-04, 2023.

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DEPARTMENT	: ZOOLOGY
TITLE OF THESIS	: DAILY AND SEASONAL SLEEP PATTERNS IN SCHOOL STUDENTS
DATE OF ADMISSION	: 26.03.2018

APPROVAL OF RESEARCH PROPOSAL

1. D.R.C.	: 12.04.2018
2. B.O.S.	: 27.04.2018
3. SCHOOL BOARD	: 03.05.2018
MZU REGISTRATION No.	: 1332 of 2011
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EXTENSION (IF ANY)	: NIL

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ABSTRACT

DAILY AND SEASONAL SLEEP PATTERNS IN SCHOOL STUDENTS

AN ABSTRACT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

J. LALREMRUATI

MZU REGISTRATION NO.: 1332 of 2011

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DEPARTMENT OF ZOOLOGY

SCHOOL OF LIFE SCIENCES

JUNE, 2023

DAILY AND SEASONAL SLEEP PATTERNS IN SCHOOL STUDENTS

BY

J. LALREMRUATI

Department of Zoology

Name of Supervisor

Dr. AMIT KUMAR TRIVEDI

Submitted

In partial fulfillment of the requirement of the Degree of Doctor of Philosophy in Zoology of Mizoram University, Aizawl.

The biological clock is an innate timing mechanism present in almost all organisms. It contains specific molecules that interact with the cells of the body and generate endogenous timing. All tissues and organs have a biological clock. Biological clocks keep body processes running according to a schedule. Therefore, they are crucial to life's functioning and the organization and coordination of behavior. In mammals, this biological clock controls the timing of sleep and physiological processes, including feeding behavior, metabolism, body temperature, and blood pressure control, which are of fundamental significance to human health, performance, and well-being. There are two primary circadian cycles in humans, the sleep/wake cycle and the hunger-satiety cycle (Waterhouse, 2009). One of the processes influenced and controlled by circadian rhythms is sleep. Sleep is defined as a conserved behavioral state of inactivity and is a crucial part of life for most organisms. Sleep serves various significant functions. It is vital in maintaining the immune system and encourages body restoration, growth, and repair. Students aged between 10 to 19 years, who are transitioning from childhood to adulthood, are especially vulnerable to sleep loss (Carskadon et al., 1998). The biological and social changes during adolescence can disrupt health and behavior, including sleep.

Furthermore, during adolescence, the central circadian clock starts to shift later, i.e., there is a phase delay. Additionally, one crucial factor influencing adolescents' sleep is the early school schedules, with other factors such as circadian phase delay, bed-time autonomy, academic pressure, screen time, and social networking, nudges adolescents to late bedding and early rising. The human circadian system actively synchronizes (entrains) to the 24 hours day via environmental signals of light and darkness (Orozco-Solis and Sassone-Corsi, 2014). Circadian rhythms are regulated by the suprachiasmatic nuclei (SCN) in the hypothalamus. The SCN regulates daily sleep/wake cycles and diurnal changes in physiological processes such as body temperature and hormone secretion such as melatonin (Weaver, 1998; Roenneberg et al., 2007). Environmental cues known as “Zeitgebers” can entrust these daily physiological processes. The daily light-dark cycle is the most reliable environmental zeitgeber. Individuals entrain differently depending on exogenous (i.e., light exposure), and endogenous (i.e., circadian response characteristics) factors that produce different phenotypes, known as chronotypes (Roenneberg, 2015).

Individuals vary in their preferred timing of daily activity patterns, like bed-time and get-up time. This morning/evening preference is a continuum but is usually divided into three chronotypes: morning type, evening type, and neither type (Horne and Ostberg, 1976). A chronotype strongly links with the quality of night-time sleep.

As a consequence of social organization and the advent of electrical lights, human sleep patterns have changed significantly in the last century. The extended presence in human-controlled environments has an impact on physiology. As more time is spent under electrical light exposure in workplaces, daily exposure to darkness and total sleep durations have decreased (Eisenstein, 2013). As a result, the production of hormones such as melatonin is disturbed (Czeisler, 2013). The impact of this metabolic alteration depends on the age, sex, and activity schedule (work, school, social interaction) of each individual. As a result, individual behavior patterns may vary due to the interaction between rhythmic psychobiological activities and the circadian timing system (Hidalgo et al., 2002). Social schedules may also affect circadian rhythmicity, although the extent of this impact depends on individual characteristics (Korczak et al., 2008). Variability in sleep patterns and activity schedules, combined with circadian preferences and adaptability related to a shift in circadian preference from morning to evening type, may result in sleep deprivation or deficits in children and adolescents.

The present thesis includes an investigation of sleep patterns, self-rating depression levels, and gender-wise differences in the population of school students within Aizawl City, Mizoram. The difference in sleep/wake timing between weekdays and weekends and seasonal sleep variation was also analyzed. The changes associated with chronotype, sleep pattern and depression among school students during the pandemic Covid-19 was examined. The study also compares academic grade points between school and university students. We also studied sleep quality, and self-rating depression levels among university students and working adults. Identification and correlation of food addiction with chronotype, depression level, and sleep quality were also analyzed in the present study. Data obtained from various studies were further analyzed statistically. To compare values at two-time points, the student's t-test was used. One-way analysis of variance (One-way ANOVA), followed by Newman-Keuls multiple comparisons test, and Tukey's multiple comparisons test, was employed for group comparisons. Significance was always taken at $P < 0.05$. All the statistical analysis was done using graph pad Prism version 8. Various studies conducted are summarized in the following sections.

SECTION 1. TO STUDY SLEEP DURATION AND SLEEP QUALITY

Sleep duration varies depending on age, gender, and other factors. It is considered as an important factor for the health of young people. Short sleep duration is associated with unhealthy risk behaviors, such as alcohol and tobacco use, which increases the risk of developing hypertension, obesity, diabetes, hypercholesterolemia, and even mortality (Watanabe et al., 2010; Wheaton et al., 2016; Liu et al., 2017). In contrast, long sleep duration can also be associated with adverse outcomes, such as increased risk of cardiovascular disease, and cognitive impairment (Bin et al., 2013; Shankar et al., 2008). There has been no gold standard criterion for short and long sleep duration. Epidemiological studies usually defined self-reported short sleep duration as less than 6 or 7 hours per day, and long as 8 or 9 hours per day, respectively (Bin et al., 2013; Silva et al., 2016). Sleep duration changes throughout the life cycle, from childhood to adulthood, generally decreasing as children get older (Shi et al., 2010). In most cases, disruption of the sleep cycle is an early sign of physical and mental illnesses (Tahmasian et al. 2020). Good quality of sleep is necessary to perform routine daily functions, including metabolic activities, hormonal processes, and proper appetite regulation (Maheshwari and Shaukat, 2019; Van Cauter et al., 2008). Additionally, adequate duration and good quality of sleep are directly related to a regular body composition index, less depressive symptoms, and better academic performance.

Given the importance of sleep for students, therefore, the present study was conducted among different school students within Aizawl City, the capital of the state of Mizoram in India. It is located in the north-eastern part of the country. The study aimed to determine sleep duration and sleep quality among school-going students. The study includes 900 male and female participants, and the age group ranged between 14 to 20 years. Different self-administered questionnaires were used, such as Morningness-Eveningness Questionnaire (MEQ) (Horne and Ostberg, 1976), Pittsburgh's Sleep Quality Index (PSQI) (Buysse et al., 1989), Pediatric Daytime Sleepiness Scale (PDSS) (Drake et al., 2003), Epworth Sleepiness Scale (ESS) (Johns, 1999), Cleveland Adolescent Sleepiness Questionnaire (CASQ) (James et al., 2007), and Zung Self-Rating Depression Scale (SDS) (Zung, 1965). 456 students' sleep/wake patterns were recorded by using actigraphy to measure different sleep parameters. Data were analyzed using One-way analysis of variance (One-way ANOVA), followed by Tukey's multiple comparisons test to identify significant differences. Significance was taken at $P < 0.05$. Our results showed that neither type (NT) of students dominated the study population, followed by morning type (MT) and evening type (ET). Most of the school students' sleep duration was identified as 7.00 - 7.90 hours, and only a few students reported their sleep duration as less than 5.00 hours. Our results demonstrate that the ET participants showed poor sleep quality and more daytime sleepiness compared to MT and NT. Higher self-rating depression level was also observed among ET. Further, we compared the actigraphy report between MT, NT, and ET, and a differential actigraphy report was observed among the three chronotypes with poor sleep quality among ET participants. In summary, our study suggests that in comparison to ET, MT participants proposed the importance of having an awareness of adequate and good sleep quality among students. Insufficient sleep can cause lack of concentration, reduced cognitive abilities, and risk-taking behaviors. Therefore, among adolescents, there is a greater need to support growing healthy sleep habits.

SECTION 2. TO STUDY GENDER DIFFERENCES IN SLEEP HABITS, SLEEP QUALITY, AND DAYTIME SLEEPINESS

There is an increasing interest in research about the influence of sex and gender on health in general. Sleep properties, like bed timing and get-up time, may significantly vary by age and gender. Several studies have shown sex differences in sleep quality and quantity, with females reporting more complaints about poor sleep than males (van Zundert et al., 2015; Collado et al., 2012; Galland et al., 2017). These differences appear to be related with higher pubertal stages among female, when compared to males of the same chronological age. Previous studies demonstrated that females had significantly earlier wake times during weekdays than males, and that they were more likely to report daytime sleepiness or even falling asleep more efficiently during the afternoon (Lee et al., 1999). Besides, it is well-known that females are more likely to be depressed than males. However, it is well-established that there is no gender difference in depression before early adolescence (Nolen-Hoeksema and Girgus, 1994). The gender difference in depression emerges between the ages of 11 and 15 (Cyranowski et al., 2000), and the size of the gender difference increases in adulthood (Kessler et al., 1993). Sex differences in chronotype have also been testified, and most studies have shown that males are more prone to show the evening chronotype or late chronotype than females (Randler and Engelke, 2019). There is still much to learn about sex-related outlines of sleep patterns among adolescents. Therefore, this study aimed to examine gender differences in sleep patterns among school students. A total of 900 school students participated in this study, and age of the participants ranged from 14-20 years.

A self-administered Morningness-Eveningness Questionnaire (MEQ) (Horne and Ostberg, 1976), Pittsburgh's Sleep Quality Index (PSQI) (Buysse et al., 1989), Pediatric Daytime Sleepiness Scale (PDSS) (Drake et al., 2003), Epworth Sleepiness Scale (ESS) (Johns, 1999), Cleveland Adolescent Sleepiness Questionnaire (CASQ) (James et al., 2007), and Zung Self-Rating Depression Scale (SDS) (Zung, 1965) was used in the study. Armband actigraphy was used to record sleep/wake patterns, and 456 students' actigraphy report was collected. An unpaired student t-test was used to analyze data. Significance was taken at $P < 0.05$. Gender-based differences in the sleep patterns were observed; the global PSQI score was significantly higher in males than females. However, more daytime sleepiness and higher self-rating depression levels were identified among females. There was also a significant difference in the actigraphy report between males and females. Significant delay in bed-timing and get-up timing was found among male participants as well as sleep onset latency. However, females spent more time in bed and had a higher number of waking minutes and mid-sleep time. To conclude our findings, our results suggest gender-dependent sleep quality and depression levels among school students. Further studies should clarify gender-specific on sleep patterns and depression level, and explore the underlying mechanism.

SECTION 3. TO STUDY THE PERSISTENCE OF SOCIAL JETLAG

Social jetlag is defined as the sleep/wake timing difference between weekdays and weekends (Wittmann et al., 2006; Roenneberg et al., 2007). Due to the combination of a shift towards later chronotype and early school start times, adolescents experience short sleep during the school week and more social jetlag than adults (Wittmann et al., 2006; Roenneberg et al., 2004; Wheaton et al., 2015). Social jetlag affects almost all of us throughout life, especially adolescents. Today's adolescents and young people are at an increased risk of social jetlag because of electronic media habits. The negative effect on sleep (both delayed and shortened), because of inappropriate electronic media use among adolescents and young person is alarming (Cain and Gradisar, 2010). In adolescent studies, social jetlag has been associated with an unhealthy dietary pattern, depressive symptoms, and multiple metabolic risks (Levandovski et al., 2011; Wong et al., 2015; Koopman et al., 2017; Mota et al., 2019). Sleep is a basic component for the growth of adolescent health, and sleep (both psychologically and physiologically) is important. However, the prevalence rate of sleep complaints is comparatively high among adolescents, where cumulative sleep debt has been associated with behavioral problems, poor school achievements, and fatigue (Touitou, 2013). Thus, the effect on sleep have been the object of many studies addressing the permanent social jetlag that many adolescents experience, and this should be considered as a problematic in public health (Touitou, 2013; Johansson et al., 2016). In this study, we examined sleep patterns during weekdays and weekends.

A total participant of 456 school students' sleep/wake patterns were recorded by using armband actigraphy for four consecutive days i.e., from Thursday to Sunday. Morningness-Eveningness Questionnaire (MEQ) (Horne and Ostberg, 1976) was used to measure chronotype. Various sleep properties of actigraphy reports were analyzed. Paired student t-test was used to analyze data. Significance was taken at $P < 0.05$. Our results reveal that there are significant differences in the different sleep parameters during weekdays and weekends. These properties are independent of gender. Delayed bed-time and get-up time were observed during weekends.

Similarly, school students spent more time in bed during weekends and had higher total sleep time and sleep onset latency. Among male participants, there was a delayed bed-timing and get-up time, and they spent more time in bed, and a higher number of total sleep times was observed during weekends. In the case of females, significant differences were identified in delayed bed-time, time in bed, total sleep time, and sleep onset latency. We also compared the actigraphy report based on chronotype; among MT, a significant difference was observed in wake after sleep onset, and in NT, there was a difference in bed-time, get-up time, time in bed, and total sleep time. However, a significant difference was not observed in all sleep parameters in the case of ET. These findings suggest that those with higher social jetlag may engage in several behaviors that are alert for health; however, more research is needed to investigate the relationships between negative social jetlag and human health. Hence, it is essential to increase awareness to reduce social jetlag about its adverse effect and inform about sleep hygiene to school students. Our study demonstrates that these days the modern wearable technologies tracking sleep/wake patterns are becoming powerful tools in the field of chronobiology.

SECTION 4. TO STUDY SEASONAL SLEEP VARIATIONS

The rotation of the Earth around its axis leads to daily changes in light intensity, while the tilt of the Earth's rotational axis as it orbits the Sun leads to seasonal variations. A change in the zeitgeber signal is critical for the entrainment of the circadian clock. Seasonal changes in sleep are well-documented. Previous studies reported that inhabitants experience remarkable seasonal changes in daylight in high-latitude areas. In these areas, a phase-delayed nocturnal sleep period and a slight but significant decrease in sleep efficiency were more induced in winter than in summer (Friborg et al., 2012; Lowden et al., 2018). Seasonal climatic changes act as rhythmic external cues or perturbations on biological systems that regulate homeostatic and endogenous processes. The response of the systems to these seasonal inputs results in seasonal variations of biological variables, such as those of sleep properties (Sollberget, 1963; Honma et al., 1987; Kohsaka et al., 1992). Seasonal variations in sleep quality or prevalence of insomnia have been well-studied in associations with characteristic seasonal changes in sunlight durations, such as the midnight sun in summer and the dark period in midwinter. Seasonal changes in sleep duration are most pronounced among individuals with sleep and mood disorders (Reynolds and Kupfer, 1987; Wehr, 1988, Anderson et al., 1994). Numerous studies have found a higher incidence of depression with hypersomnia during winter than in other seasons (Hardin et al., 1991; Wehr et al., 1991; Rosenthal et al., 1984).

Therefore, the current study aims to investigate sleep variations across seasons. Total participants of 456 school students were requested to fill out the Horne and Ostberg Morningness-Eveningness Questionnaire (MEQ) (Horne and Ostberg, 1976) to measure chronotype, and their sleep/wake patterns were recorded by using armband actiwatch. One-way analysis of variance (One-way ANOVA) was used to analyze data, followed by Tukey's multiple comparisons test. Significance was taken at $P < 0.05$. Repeated measurements were conducted over four months to examine the seasonal differences in sleep habits, i.e., March, June, September, and December. When we analyzed the different parameters of the actigraphy reports between the four months, the actigraphy data were differentiated across the season. Our results suggest that get-up time, time in bed, total sleep time, sleep onset latency, wake after sleep onset, and mid-sleep time vary annually. When examining seasonal effects on get-up time, we found the effect of winter to be associated significantly with delayed get-up time during December. Differences in sleep properties were also identified among male and female actigraphy reports. Among female participants, there was a significant difference in bed-timing. Further, the chronotype-dependent analysis also confirms the effect of chronotype on various sleep parameters of the actigraphy report. This comprehensive approach allowed us to determine whether seasons influence sleep in the industrial world and, at the same time, provides a more unifying viewpoint about sleep that is contextualized with respect to earlier studies.

SECTION 5. CHANGES ASSOCIATE WITH CHRONOTYPE, SLEEP PATTERN AND DEPRESSION LEVELS AMONG SCHOOL STUDENTS DURING PANDEMIC COVID-19 LOCKDOWN AND POST-LOCKDOWN ONLINE CLASSES

The World Health Organization (WHO) has declared that the outbreak of the novel coronavirus disease 2019 (COVID-19) at the end of 2019, is an international public health emergency. The outbreak of COVID-19 infected more than 1.2 million people worldwide. People affected by this disease have been experiencing different degrees of anxiety, depression, panic attacks, and insomnia (Goulia et al., 2010; Tsang et al., 2004). Vast resources have been assigned to control the pandemic and treating patients, which differ among and within countries. However, there are common response actions such as substantial periods of social isolation with a restriction of movements, lockdown, and stay-at-home (Lin, 2020; Pakpour and Griffiths, 2020). Social distancing measures have also been imposed.

Furthermore, the vast majority of day-to-day activities, such as work and education, have become online efforts with uncertain effect on physical and mental health. These extreme guidelines greatly changed lifestyles and social relationships and, with the fear of contracting the infection, have probably generated profound anxiety levels. Therefore, it is reasonable to speculate that psychological conditions may be compromised during the COVID-19 outbreak, not only in the population directly affected by the virus but also in the general population. Many previous studies found that mental health is associated with physical activity, sleep quality, and quality of life in both clinical and non-clinical populations. The pandemic significantly affected all the areas like industries, education etc.

Taking the issues and facts described above into consideration, the present study examined chronotype, sleep pattern, and depression levels among school students during the pandemic Covid-19 lockdown and post-lockdown online classes. The study was conducted in three phases. The first phase of the study was performed during April to July, 2019 (during offline class), the second phase was conducted between April to May, 2020 (during lockdown), and the third phase was completed from July to August, 2021 (during post-lockdown online class). 100 school students participated in the study, and the age group ranged from 14-20 years. A different self-administered questionnaire was used in the study: Morningness-Eveningness Questionnaire (MEQ) (Horne and Ostberg, 1976), to measure chronotype, daytime sleepiness, and sleep quality was assessed by Epworth Sleepiness Scale (ESS) (Johns, 1999), and Pittsburgh's Sleep Quality Index (PSQI) (Buysse et al., 1989), and Zung Self-Rating Depression Scale (SDS) (Zung, 1965), was used to measure the depression level. One-way ANOVA, followed by Newman-Keuls multiple comparison test, was performed to determine the differences during offline class, lockdown, and during online class periods. Significance was taken at $P < 0.05$. In the study's first phase, the students were approached individually via school administration, and the study was conducted offline. The second and third phase was conducted through an online questionnaire. The study's first phase included more than 100 school students, but some students did not participate during the second and third phases, so their data was not included in the analysis. When we compared the percentage of chronotype between the three study phases, there was an increase in the ET, and a decrease in the MT and NT participants during the lockdown and online classes compared to offline classes. In addition, a higher self-rating depression levels, more daytime sleepiness, and poor sleep quality were observed during the lockdown and online classes, irrespective of gender. In summary, during the peak phase of the COVID-19 outbreak, the severity of the COVID-19 outbreak had an indirect effect on school students' negative emotions, with sleep quality mediating.

SECTION 6. CHRONOTYPE-DEPENDENT ACADEMIC PERFORMANCES AMONG SCHOOL AND UNIVERSITY STUDENTS

Sleep plays a crucial role in cognitive and emotional functioning, especially during adolescence, when the biological sleep/wake cycle changes rapidly. Lifestyle changes during adolescence may be accompanied by profound alterations in the timing and duration of sleep. These days, many adolescents do not get enough sleep and may suffer the adverse effect of insufficient sleep. Sleep habits and specific sleep behaviors influence the academic success of students. The academic performance of adolescents is important for their psychosocial development and to prepare them for adulthood. Adolescents' learning capacity and academic performance may be affected by sleep quality or quantity because sleep plays important role in attention and memory. Several studies have reported an association between academic performance and adolescent sleep duration (Curcio et al., 2006). Inadequate sleep is related to emotional problems, such as depression and impulsiveness (Lee et al., 2012; Kamphuis et al., 2012). Poor academic performance among adolescents has also been associated with depression or impulsiveness (Lazaratou et al 2010; Weithorn et al., 1984). Sleep and academic performance is a critical research domain, particularly in the later adolescent years, as school performance is linked closely to subsequent educational and work attainment. Sleep and academic performance may be related through several pathways and mechanisms. A direct effect of sleep has been shown in experimental studies in which sleep restriction has impaired learning and memory performance in early adolescence (Curcio et al., 2006).

There is an increasing awareness about the effect of circadian misalignment on health and work. In the present study, we aimed to investigate chronotype's effect on school students' academic achievement. This study looked at disparities in teenage academic performance depending on chronotype and gender and compared them with the data of adolescents with university students. The study included 427 school students, and 437 university students. Morningness-Eveningness Questionnaire (MEQ) (Horne and Ostberg, 1976) was used to measure chronotype, and their grade points were collected. The age group of volunteers from school students range between 14 to 20 years, while among university students age group range from 19 to 29 years. Student t-test was applied to check the differences when comparing two point values. One-way analysis of variance (one-way ANOVA) was used to determine the significant differences among groups. Tukey's multiple comparisons test was used for significant interactions. Significance was taken at $P < 0.05$. Our results suggest that MT participants had better academic achievements, than NT and ET in all participants and among males and females. In addition, gender-wise academic scores were analyzed, and females had better academic scores than males in the overall participants, and among school and university students. Further, the two groups' academic grade points were compared, and higher scores were observed among university students. These findings suggest that chronotype and gender influence academic success in turn to scores achieved. In summary, these results highlight the importance of sleep for academic functioning. If adolescents cannot perform according to their academic potential, this may have important short-term consequences for their academic performances, but again may give rise to a range of negative adult functional outcomes.

SECTION 7. STUDY OF FOOD ADDICTION, CHRONOTYPE, DEPRESSION LEVEL, AND SLEEP QUALITY AMONG SCHOOL, UNIVERSITY STUDENTS, AND WORKING ADULTS

Food addiction (FA) refers to a state characterized by craving, compulsive eating, and, possibly, the presence of food constituents with drug-like properties, which decline the willpower to abstain from their consumption (Nolan, 2017). It can also be defined as an insatiable craving for the consumption of specific high-fat, high-sugar foods beyond the required energy needs for sustenance or a hedonic eating behavior involving the consumption of highly palatable foods (i.e., foods high in salt, fat, and sugar) in quantities beyond homeostatic energy requirements (Cathelain et al., 2016). Stress significantly affects eating behavior, which influences the hypothalamic-pituitary-adrenal axis functioning. While chronic exposure to stress and hyperphagia seems positively associated with obesity, stress-induced reductions in food intake have also been reported. In addition to being associated with stress, the relationship between sleep quality and FA is interesting to consider. Sleep/wake cycles and food intake are known to be directed by the circadian rhythm. Moreover, only one published study examined associations between FA and chronotype, and although there was no significant direct linear relationship between them, evening type circadian preferences was indirectly associated with higher food addiction scores mediated by insomnia and impulsivity (Kandeger et al., 2018). Studies on FA are increasing with the growing interest in nutrient-rich diets, especially in children and adolescents. Studies have pointed out that stress is the leading cause of the development of addictive behaviors and the inability to quit such behaviours (Hardy et al., 2018; Mitchell et al., 2016). The degree of psychological and social stress experienced by individuals and the number of stressors in life are highly correlated with overeating and unhealthy eating patterns, such as a low intake of vegetables and an increased intake of high-calorie foods (Mitchell et al., 2016; Errisuriz et al., 2016; Neseliler et al., 2017). With the rapid increase in obesity prevalence, food addiction has become a popular topic. Since there is a lack of knowledge about the addiction to food or eating in human beings, thus, this study aimed to identify and correlate food addiction (FA) with depression level, and sleep patterns among school students, university students, and working adults.

The study included 1234 participants, 607 school students, 342 university students, and 285 working adults. The study was conducted by using Morningness-Eveningness Questionnaire (MEQ) (Horne and Ostberg, 1976), Pittsburgh's Sleep Quality Index (PSQI) (Buysse et al., 1989), Zung Self-Rating Depression Scale (SDS) (Zung, 1965), and Yale Food Addiction Scale (YFAS) (Gearhardt et al., 2009). Student t-test was used to analyze the differences when comparing two point values. One-way ANOVA, followed by Tukey's multiple comparison test, was performed to determine the differences between the three groups. Significance was taken at $P < 0.05$. Our results suggest that the highest chronotype percentage was observed among NT, followed by MT and ET in the overall participants, school students, and working adults.

In the case of university students, the highest percentage of chronotype was identified in NT, whereas the percentage of ET was slightly higher than MT. When we analyzed the percentage of FA, the highest percentage of FA was observed among university students, than among working adults and school students. The gender-wise comparison was also analyzed, and female participants showed a higher FA percentage than males. Further, the highest percentage of FA was found among ET based on chronotype among the three studied populations. The lowest self-rating depression level was observed among working adults. However, poor sleep quality was found among university students. Pearson Correlation Coefficient was used to analyze correlation between FA and the other parameters. A positive correlation was identified between FA and depression level, similarly, between FA and sleep quality. For the healthy development of adolescents, it is critical to prioritize physical activity, appropriate media use, and healthy dietary behaviors, as well as to develop various programs and opportunities for daily support. A comprehensive evaluation of addiction symptoms is necessary, especially for adolescents with symptoms of unhealthy eating behaviors.

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