Examining the relationship between Sleepiness, Fatigue, and Depression Among the Students

Abstract:

Fatigue and excessive daytime sleepiness (EDS) are frequently conflated in everyday life, but they are separate concepts with distinct symptoms. Despite their potential to coexist or occur independently, their interplay with depression remains largely unexplored. This study investigates the complex relationship between fatigue, excessive daytime sleepiness (EDS), and depression among students, aiming to unravel their relative associations. A cross-sectional survey of Indian school students (N=450) aged 11 to 20 (15.2±1.46)was analysed. The study used self-reported measures such as the Fatigue Severity Scale (FSS), Epworth Sleepiness Scale (ESS), and the Center for Epidemiologic Studies Depression Scale (CES-D). The findings revealed significant associations between depression and various combinations of sleepiness and fatigue, with the $E^{+}F^{+}$ group showing the strongest correlation. Depression was significantly higher in excessive daytime sleepers (N= 165, 69.9%) ($P < 0.001$) and fatigue (N= 167, 70.8%) ($p< 0.001$). Depression was found positively correlated with fatigue ($r =0.332$, $p < 0.001$ and daytime sleepiness ($r=0.213$, $p<0.001$). Chronotype was found negatively correlated with fatigue ($r=-0.124$, $p<0.001$), daytime sleepiness ($r=-0.105$, $p<0.05$), and depression ($r=-0.198$, $p<0.001$).These findings underscore a significant association ($p<0.001$) between depression and the presence of both excessive daytime sleepiness and fatigue. This revelation demands a nuanced approach to mental health interventions, recognizing the shared underlying mechanisms and advocating for comprehensive strategies that address these intertwined facets of student well-being.

Keywords: Chronotype, Depression, Fatigue, Sleepiness

Abbreviations
r-MEQ: reduced MorningnessEveningness questionnaire
CT: Chronotype
MT: Morning Type
ET: Evening Type
NT: Neither Type
EDS: Excessive daytime sleepiness
FSS: Fatigue Severity Scale
ESS: Epworth Sleepiness Scale
CES-D: Center for Epidemiologic Studies Depression Scale

1.Introduction

Fatigue and excessive daytime sleepiness (EDS) frequently have similar meanings in everyday life. These two terms, however, are distinct concepts[1,2].Fatigue and EDS can coexist, but they can also exist independently and with distinct symptoms[1]. A population-based study in the

Netherlands found that 30.5% of adults have chronic fatigue for more than six months[3]. Fatigue is also widespread in the Korean general population, with estimates ranging from 21-31% [4,5]. The association between EDS and depression has been established in both sleep disorders [6]and the general population[7]. Several self-report measures have been developed to assess the severity and prevalence[8]. The Fatigue Severity Scaleis the most commonly used for fatigue measurement[9]. Furthermore, fatigue is more common in people who have neurological diseases like multiple sclerosis, Parkinson's disease, and traumatic brain injury[10]. It is also linked to psychological issues such as depression, anxiety, and emotional stress[11]. Sleepiness, characterized by an overwhelming urge to sleep during waking hours, and fatigue, encompassing both physical and mental exhaustion, represent significant facets of sleep-related disturbances, in contrast to fatigue[12].

Excessive daytime sleepiness (EDS) is the tendency to fall asleep despite deliberate attempts to remain alert. Chronic sleep loss and poor sleep quality are the primary underlying causes of EDS[13]. They are present in several sleep disorders, including obstructive sleep apnea and narcolepsy, as well as psychiatric disorders, particularly depression. Approximately 80% of depressive episodes are accompanied by comorbid insomnia, whether related or not to EDS[13]Sleep is regulated by the interaction of sleep homeostasis and circadian rhythm, whereas exertion plays a pivotal role in the occurrence and consequences of fatigue[14]. Fatigue and sleepiness are frequently used interchangeably because both conditions produce tiredness symptoms that overlap. However, people who complain of fatigue are not always tired, and vice versa[1]. Excessive daytime sleepiness (EDS) is commonly recognized as a symptom of sleep disorders such as obstructive sleep apnea, periodic limb movement disorder, poor sleep hygiene, and chronic sleep deprivation[15]. Aside from sleep, circadian rhythms are important in the relationship between depression and EDS[16]. Depression is strongly linked to biological rhythms on a variety of levels, including neurobiological systems that support both the pathophysiology of depression, such as the serotonergic system, and the clinical aspects of depression[16]. Circadian misalignment can be caused by human circadian system disorders, resulting in sleep disturbances (specifically, insomnia and/or EDS), reduced attention and impaired daytime alertness, a lack of energy, poor performance, a negative mood, and gastrointestinal disorders. Interestingly, these symptoms also occur in depression, which further extends the idea that depression and circadian rhythms are intimately connected[16].

The effects of Excessive Daytime Sleepiness (EDS) and fatigue on depression constitute a complex interplay that has garnered inadequate attention in scientific inquiry. Despite their potential to manifest independently or sequentially, the nuanced dynamics between these factors remain largely unexplored. The current study endeavors to fill this gap by delving into the intricate relationship between fatigue, EDS, and depression among students.While their implications for mental health have been recognized, their comparative influence on depression remains elusive. By examining the relative associations of fatigue and EDS with depressive symptoms, this study aims to unravel their differential impacts within the student population.

2.Materials and methods

2.1Participants

The data for this study was obtained from a comprehensive cross-sectional epidemiological survey that investigated chronotype, depression, excessive daytime sleepiness (EDS), and the

Fatigue Severity Scale (FSS). The study included a broad and representative sample of Indian school students aged 11 to 20 years (15.2±1.46), with 305 males (67.8%) and 145 females (32.2%). In addition to evaluating the aforementioned characteristics, the authors conducted an investigation into the participants' demographic profiles and socioeconomic statuses in March 2022. It is important to note that all participants provided explicit written consent before they participated in the study, demonstrating the ethical integrity of the research procedure.

2.2 Evaluation of Fatigue, Sleepiness, Chronotype and Depression

2.2.1 Fatigue Severity Scale (FSS)

The self-reported Fatigue Severity Scale (FSS), one of the most commonly used fatigue assessment indexes, was used to measure fatigue[9].This questionnaire has nine items that measure the exerting influence of fatigue on specific situations of functioning and the behavioral consequences of fatigue. Each item is rated from 1 (strongly disagree) to 7 (strongly agree). The authors calculated the FSS score as the total summation of all nine items. We defined the presence of fatigue as an FSS score≥36.

2.2.2 Epworth Sleepiness Scale (ESS)

Daytime sleepiness was assessed using the Epworth Sleepiness Scale (ESS), an eight-item questionnaire that measures the likelihood of dozing in eight situations[17]. The total ESS score ranges from 0 to 23, and scores≥11 indicate EDS in this study. The combination of EDS and fatigue was classified into four categories as follows; EDS with fatigue (E^+F^+, ESS≥11, FSS≥36), fatigue without EDS (E^-F^+, ESS < 11, FSS ≥ 36), EDS without fatigue (E^+F^-, ESS≥11, FSS<36), and no fatigue and EDS (E^-F^-, ESS<11, FSS<36).

2.2.3 Reduced-MorningnessEveningnessQuestionnaire (r-MEQ)

The r-MEQ was developed by Adan et al.[18]and only includes items 1, 7, 10, 18, and 19 of the original MEQ[18]. r-MEQ is used to self-assess the chronotype (CT) of the individuals. The questionnaire has 5 questions and the score range from 4 to 26. Whereby the higher score indicates the Morningness chronotype. The same cut-off scores for determining CT groups were used in Adan et al.[18], (Eveningness chronotype: < 12; Neither chronotype: 12–17; morning: >17). The validated scoring was used where the first four questions were scored 1–5 and question 5 was scored 0–6.

2.2.4 Center for Epidemiologic Studies Depression Scale (CES-D)

Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (CES-D)[19]. CES-D is among the most frequently used measures for assessing the level of depressive symptoms and is a well-validated self-report measure of depressive symptoms in adults in the community[20]. CES-D is a 20-item and the score range from 0-60. CES-D measure that assesses the frequency of depression during the past week on a 0–3 Likert scale (“rarely or none of the time” to “most or all of the time”). The standard cut-off is ≥16 for “possible depression”[19].

2.3 Statistical analyses

The normality of the dataset was determined using the Kolmogorov-Smirnov test. Categorial variables were shown as frequency and Percentage. Categorical variables were compared using the chi-square test ($p < 0.05$). One-way analysis of variance (ANOVA) was used to compare the means of two or more independent groups. P values <0.05 were considered statistically significant with a 95% confidence interval (CI). Pearson / Spearman's correlations were used to assess the strength of relationships between variables. Multiple regression analyses were used to investigate the relationship between daytime sleepiness, fatigue, depression, and chronotype. The dependent variable for linear regression was depression, while the independent variables were fatigue, daytime sleepiness, and chronotype. The data analysis and graph preparation were performed using Statistical Package for the Social Sciences (SPSS) 26.0 (IBM Corporation, NY, USA) and GraphPad Prism Software version 8.0, San Diego, USA.

3.Results

3.1 Characteristics of Participants

A total of 470 participants responded to this questionnaire study. The authors excluded twenty participants due to missing data of fatigue, depression, or the sleepiness scale. After exclusions, the authors analyzed data from 450 participants. The proportion offemales was N=145 (19.4%)and males was N=305 (40.8%).

3.2 Comparison of Sleepiness, Depression, and Fatigue with Chronotype:

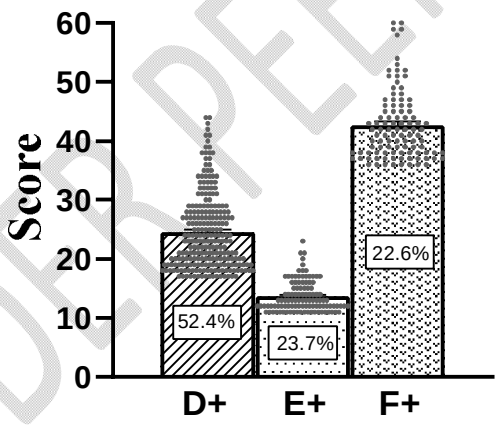

Figure1. Represent the Depression, Sleepiness and Fatigue scores among the participants.
D+, presence of depression; E+, presence of sleepiness; F+, presence of fatigue

Fig. 1-3 demonstrate the composite scores of CES-D (>16 =D+), ESS (≥11 =E+), and FSS (≥36 =F+) among 450 participants. Results (Fig.1) show that 52.4% exhibited symptoms of depression, 23.7% were daytime sleepers, and 22.6% were fatigued. Fig. 2 further breaks down these findings by chronotype, Fig 2(a) demonstrated the depression score among the chronotype where MT (23.02±5.77), NT (24.73±6.08), and ET (28.62±8.02) which revealed that people with an evening type (ET) demonstrated higher levels of depression and ET was also found highly significant different with MT (p=0.000) and NT (p=0.013). Fig 2(b) shows the sleepiness score

among the chronotype MT (13.28±2.22), NT (13.59±2.20), and ET (13.00±1.22) whereas Fig 2(c) shows the fatigue score among the chronotype MT (40.50±3.56), NT (41.25±3.75), and ET (42.62±3.66), both were not found significantly different from each other.

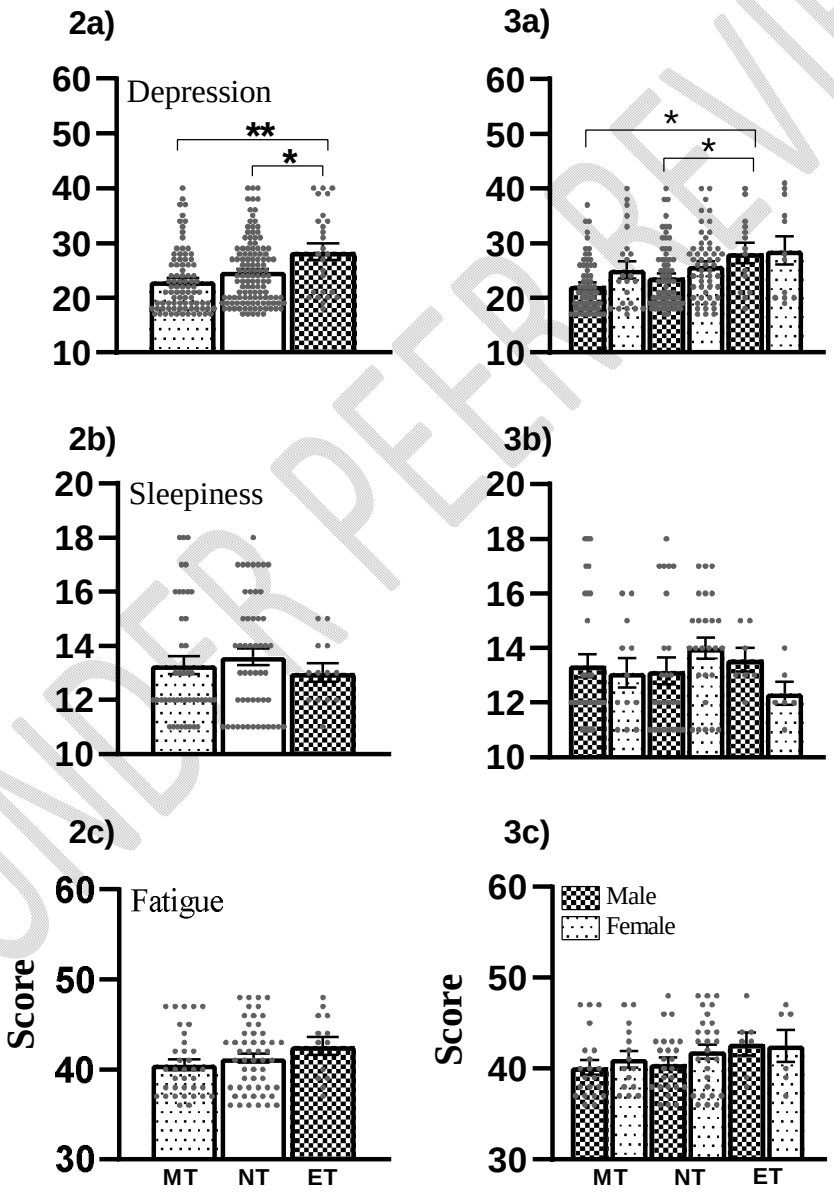

Figure 2 and 3: Comparison of Depression, Sleepiness and Fatigue with Chronotype among the participants. Figure 2a shows the depression, 2b shows the Sleepiness and 2c shows the Fatigue score among the chronotype. Figure 3a, shows the depression, 3b shows sleepiness and 3c shows the fatigue score in between the gender and chronotype.

Fig3 delves into gender differences among the chronotypes, where Fig 3(a) shows the depression score with chronotype where MT male (22.23±4.87) female (25.22±7.43), NT male (23.77±5.85) female (25.96±6.19), ET male (28.29±7.14) female (29.00±9.25), showing that females exhibited higher rates of depression across all chronotypes. ET males were found to be highly significantly different from MT(p=0.001) and NT (p=0.017) males. Fig 3(b) shows the sleepiness score among the chronotype with gender differences where MT male (13.35±2.36) female (13.08±1.88), NT male (13.16±2.39) female (14.00±1.96), ET male (13.57±1.13) female (12.33±1.03). Fig 3(c) shows the fatigue score MT male (40.62±3.66) female (41.00±3.53), NT male (40.52±3.28) female (41.89±4.07), ET male (42.71±3.35) female (42.50±4.32).

Table 1 lists the study participants' demographic, r-MEQ, and social behavior characteristics, and according to the presence of depression. Participants with depression showed a significant preponderance for being female (N = 89, 37.7%) (p< 0.05). Age range from 16-20was significantly related to depression (N=108, 45.8%) (p< 0.05). The subjects who preferred to be in the group were significantly related to depression (N=153, 64.8%) (p<0.001).Depression was significantly higher in ESS (N= 165, 69.9%) (p< 0.001) and fatigue (N= 167, 70.8%)(p< 0.001), respectively.

Table 1: Characteristics of participants according to the presence of depression

Variables		**Total**	**Depression (-)**	**Depression (+)**	**X^2-value**	**df**	**p-value**
Gender	Male	305 (67.8)	158 (73.8)	147 (62.3)	6.848	1	**0.009**
	Female	145 (32.2)	56 (26.2)	89 (37.7)			
Age	11-15	264 (58.7)	136 (63.6)	128 (54.2)	4.015	1	**0.045**
	16-20	186 (41.3)	78 (36.4)	108 (45.8)			
Education level	Class 8-10	240 (53.3)	120 (56.1)	120 (50.8)	1.232	1	0.267
	Class 11-12	210 (46.7)	94 (43.9)	116 (49.2)			
Belongs to	Ruler	128 (28.4)	66 (30.8)	62 (40.3)	1.152	1	0.283
	Urban	322 (71.6)	148 (69.2)	174 (73.7)			
Family status	Joint	186 (41.3)	91 (42.5)	95 (40.3)	0.238	1	0.625
	Nuclear	264 (58.7)	123 (57.5)	141 (59.7)			
Prefer to	Live alone	129 (28.7)	46 (21.5)	83 (35.2)	10.262	1	**0.001**

	In group	321 (71.3)	168 (78.5)	153 (64.8)			
Chronotype	MT	179 (39.8)	92 (43.0)	87 (36.9)	5.774	2	0.056
	NT	234 (52.0)	111 (51.9)	123 (52.1)			
	ET	37 (08.2)	11 (05.1)	26 (11.0)			
ESS	Normal	343 (76.2)	178 (83.2)	71 (30.1)	10.892	1	**0.001**
	Sleepiness	107 (23.8)	36 (16.8)	165 (69.9)			
FSS	Normal	348 (77.3)	181 (84.6)	69 (29.2)	12.223	1	**0.000**
	Fatigue	102 (22.7)	33 (15.4)	167 (70.8)			
ESS<11, FSS<36	E^-F^-	286 (63.6%)	155 (34.4%)	131 (29.1%)	18.608	3	**0.000**
ESS≥11, FSS<36	E^+F^-	62 (13.8%)	26 (05.8%)	36 (08.0%)			
ESS≥11, FSS≥36	E^+F^+	45 (10.0%)	10 (02.2%)	35 (07.8%)			
ESS < 11, FSS ≥ 36	E^-F^+	57 (12.7%)	23 (05.1%)	34 (07.6%)			

In four categories according to the presence combination of ESS and fatigue,E^-F^- (N=131, 29.1%) was low in participants with depression,and E^+F^-(N=36, 8.0%) was related to participants with depression. E^-F^+(N=34, 07.6%) and E^+F^+(N=35, 07.8%) had higher participants with depression. These findings underscore a significant association ($p<0.001$) between depression and the presence of both excessive daytime sleepiness and fatigue.

3.2 Comparison of between E^+F^- and E^-F^+

Table 2 depicts the participants' characteristics of the two groups, E^+F^-(N = 62) and E^-F^+(N = 57). Compared to E^+F^-,$E^-F^+$was associated with subjects who preferred to be in the group (n= 46, 80.7%) ($p<0.05$). Gender, age, Education level, chronotype, depression, and other variables were not significantly associated with both groups.

Table2: Characteristics of participants according to excessive daytime sleepiness according to two categories

Variables		**Total**	**E^+F^-**	**E^-F^+**	**X^2-value**	**df**	**p-value**
Gender	Male	72 (60.5)	41 (66.1)	31 (54.4)	1.714	1	0.191
	Female	47 (39.5)	21 (33.9)	26 (45.6)			
Age	11-15	59 (49.6)	34 (54.8)	25 (43.9)	1.432	1	0.231

	16-20	60 (50.4)	28 (45.2)	32 (56.1)			
Education level	Class 8-10	50 (42.0)	25 (40.3)	25 (43.9)	0.153	1	0.696
	Class 11-12	69 (58.0)	37 (59.7)	32 (56.1)			
Belongs to	Ruler	30 (25.2)	15 (24.2)	15 (26.3)	0.071	1	0.790
	Urban	89 (74.8)	47 (75.8)	42 (73.7)			
Family status	Joint	55 (46.2)	30(48.4)	25 (43.9)	0.245	1	0.621
	Nuclear	64 (53.8)	32 (51.6)	32 (56.1)			
Prefer to	Live alone	33 (27.7)	22 (35.5)	11 (19.3)	3.882	1	**0.049**
	In group	86 (72.3)	40 (64.5)	46 (80.7)			
Chronotype	MT	41 (34.5)	24 (38.7)	17 (29.8)	1.047	2	0.592
	NT	66 (55.5)	32 (51.6)	34 (59.6)			
	ET	12 (10.1)	06 (09.7)	06 (10.5)			
Depression	Normal	49 (41.2)	26 (41.9)	23 (40.4)	0.031	1	0.861
	Depressed	70 (58.8)	36 (58.1)	34 (59.6)			

Depression was found positively correlated (Table 3) with fatigue ($r = 0.332$, $p < 0.001$) and daytime sleepiness ($r=0.213$, $p<0.001$). Chronotype was found negatively correlated with fatigue ($r=-0.124$, $p<0.001$), daytime sleepiness ($r=-0.105$, $p<0.05$), and depression ($r=-0.198$, $p<0.001$).

Table 3: The correlation between daytime sleepiness, fatigue, depression, and chronotype scale score

Variables	**Mean ±SD**	**1**	**2**	**3**	**4**
Fatigue	25.55 ±13.11	1			
Day time Sleepiness	8.02 ±4.03	0.451**	1		
Depression	17.84 ±8.92	0.332**	0.213**	1	
Chronotype	16.53 ±4.46	-0.124*	-0.105*	-0.198**	1

* Correlation is significant at the 0.05 level (2- tailed)
** Correlation is significant at the 0.01 level (2- tailed)

The multiple regression analysis (Table 4) demonstrated that fatigue (β= 0.281, t=5.695, p<0.001) and daytime sleepiness (β= 0.070, t= 1.425, p=0.155) were related to depression. However, there was no direct impact of chronotype on depression (β= -0.156, t= -3.522, p<0.001).

Table 4: Represented the linear regression analysis where the dependent variable was Depression (CES-D) and the independent variables were chronotype, fatigue, and Daytime sleepiness (P<0.001).

Model Depression (CES-D)	Standardized coefficient (Beta)	t	p	R	R^2	F	Model p-value
Chronotype	-0.156	-3.522	0.000	0.373	0.139	24.091	**0.000**
Fatigue	0.281	5.695	0.000				
Day time Sleepiness	0.070	1.425	0.155				

4. Discussion

The primary aim of this study was to estimate the degree of association between fatigue and excessive daytime sleepiness (EDS) with depression in the student population. Depression was significantly associated with E^+F^+,E^-F^+,and E^+F^-,compared with E^-F^-as the reference category. E^+F^+ was the most closely related to depression. This potent association between depression and E^+F^+ is consistent with the result of a previous study[21]. EDS and fatigue share aspects in relation to depression. First, EDS and unexplained fatigue are some of the symptoms that precede depression[22]. Second, EDS and fatigue are a kind of somatic symptoms caused by depression and tend to remain as a residual symptom even with pharmacological treatment through selective serotonin reuptake inhibitors(Papakostas et al., 2006).Third, EDS and fatigue tend to cluster together rather than presenting as isolated symptoms. In women of the general population, fatigue and EDS were identified as the most critical risk factors for psychiatric diseases including depression[24]. As in our study, the distribution of EDS and fatigue tended to cluster together rather than to exist separately.

The outcomes, as depicted in Table 1, revealed significant distinctions (p=0.000) among the four delineated categories of sleepiness and fatigue, all of which were closely linked with depression[25]. Notably, the E^+F^+group exhibited a higher incidence of depression (D+) in comparison to the E^-F^+ and E^+F^-cohorts, while the E^-F^-subset displayed a reduced prevalence of D+[25]. Furthermore, gender, age, preference, sleepiness, and fatigue emerged as factors

significantly associated with depression.The findings suggested a notable elevation in depression among individuals experiencing symptoms of sleepiness and fatigue[26]. This observation raises the possibility of a bidirectional relationship between depression and these symptoms, wherein depression may exacerbate sleepiness and fatigue, or vice versa. It is conceivable that the presence of depression disrupts sleep patterns, thereby contributing to daytime sleepiness and fatigue during waking hours[27].

There is ample evidence for an association between daytime sleepiness and moderate to severe depression(Breslau et al., 1997).Given that insomnia, particularly when associated with impaired daytime function, plays a key role in the onset of depression [29], it is of significant clinical importance to unravel the link between EDS and depression. Furthermore, knowledge of the interrelation between EDS and mood disorders may have ramifications for the treatment of depression (Breslau et al., 1997).

These findings underscore the substantial role played by depression in the manifestation of sleepiness and fatigue.Table 2 offered additional insights, indicating that individuals who preferred group settings ($E^{+}F^{-}$and$E^{-}F^{+}$) exhibited higher levels of depression compared to those who lived alone. This trend may be attributed to a desire for social interaction to alleviate feelings of loneliness. Similar trends were observed in Table 3, which highlighted a positive correlation between sleepiness, fatigue, and depression. Table 4 further demonstrated that depression exhibited a stronger association with fatigue than with sleepiness, suggesting a closer relationship between depression and fatigue. Collectively, these results underscore the complex interplay between depression, sleepiness, and fatigue, emphasizing the need for comprehensive approaches to addressing these interconnected phenomena.However, several limitations warrant consideration. The study's cross-sectional design precludes causal inferences, emphasizing the importance of longitudinal research to understand the temporal relationship between these variables. Furthermore, using self-reported measures may introduce response bias, and the study's sample may not be representative of the broader population.

5. Conclusion:

This study sought to investigate the link between fatigue, excessive daytime sleepiness (EDS), and depression in students. The results show a significant relationship between depression and various combinations of sleepiness and fatigue, with the $E^{+}F^{+}$group having the strongest association with depression. This aligns with prior research, suggesting a robust link between depression and the co-occurrence of sleepiness and fatigue.The study highlights several key insights. Firstly, EDS and fatigue may precede depression and persist as residual symptoms despite treatment, indicating a complex relationship wherein these symptoms may serve as both precursors and consequences of depression. Secondly, the clustering of EDS and fatigue suggests a shared underlying mechanism, further supporting their association with depression. This revelation demands a nuanced approach to mental health interventions, recognizing the shared underlying mechanisms and advocating for comprehensive strategies that address these intertwined facets of student well-being.

Consent

As per international standards or university standards, Participants' written consent has been collected and preserved by the author(s).

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