

Research

Daytime sleepiness and academic performance among respiratory therapy students in Saudi Arabia: a cross-sectional survey

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Received: 10 January 2025 / Accepted: 9 May 2025

Published online: 28 May 2025

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Abstract

Background Excessive daytime sleepiness (EDS) is a prevalent concern among health-related students, but its incidence and impact on academic performance remain unexplored in undergraduate respiratory therapy (RT) students in Saudi Arabia. This study aims to determine the prevalence of EDS and its association with academic performance.

Methods A cross-sectional online survey using the Epworth Sleepiness Scale (ESS) was distributed to RT students from January 5 to March 30, 2023. The prevalence of EDS was calculated using percentages and 95% confidence intervals, and logistic regressions identified associations with sociodemographic, sleep, and academic variables.

Results Among 925 respondents, EDS prevalence was 32% (95% CI 23–35%). The overall mean ESS score was 8.31 ± 4.4 , indicating a normal level of EDS. Current and ex-smokers were more likely to experience EDS than non-smokers [(OR): 3.28 (1.95–5.54), $p < 0.001$; (OR): 2.61 (1.35–5.07), $p = 0.004$]. Students with > 3 academic warnings had higher odds of EDS [(OR): 6.4 (1.98–20.71), $p = 0.002$]. Those napping ≥ 4 times weekly were 15 times more likely to experience EDS [(OR): 15.2 (6.94–33.35), $p < 0.001$], and students not sleeping before exams were 11 times more likely to report EDS [(OR): 11.3 (1.28–100.52), $p = 0.029$].

Conclusion EDS affects a significant proportion of RT students, with several sociodemographic, sleep, and academic factors contributing to susceptibility. Further research is needed to identify primary determinants and develop targeted interventions to mitigate EDS and its impact on academic performance.

Keywords Excessive daytime sleepiness · Academic performance · Respiratory therapy student · RT

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1 Introduction

Sleep is a fundamental physiological phenomenon essential for the restoration and activation of neurocognitive processes, thereby facilitating optimal learning outcomes [1]. It plays a pivotal role in the recuperation of energy, regeneration of physiological functions, and consolidation of memory [2]. However, insufficient sleep has been strongly associated with detrimental effects on intellectual capacities, potentially leading to deficiencies in concentration, performance, decision-making, and critical reasoning abilities [3, 4]. Consequently, it is recommended that young adults maintain a consistent sleep duration of seven to nine hours per night [5].

Excessive daytime sleepiness (EDS) is characterized by the inability to sustain an adequate level of alertness or wakefulness during diurnal hours, leading to uncontrollable episodes of drowsiness or somnolence [6]. This sleep-related symptom has substantial clinical significance, as it can manifest functional deficits attributable to various contributing factors, including sleep deprivation, obstructive sleep apnea, and psychiatric conditions [7]. EDS has been closely associated with heightened risks of occupational errors, motor vehicle accidents [47], and diminished academic performance [8, 9]. Epidemiological findings suggest that a considerable proportion, up to 33%, of adults in the United States experience pronounced daytime sleepiness [10].

A respiratory therapist (RT) represents a specialized healthcare professional pivotal in the assessment and management of individuals afflicted with cardiopulmonary diseases [11]. EDS can be a prominent complaint among undergraduate RT students, similar to their counterparts in other health disciplines. Recently, meta-analysis encompassing 109 studies and involving 59,427 participants globally unveiled that approximately 56% of medical students reported poor sleep quality, with 33% experiencing diurnal sleepiness [12]. In addition, relevant studies have illuminated that EDS significantly amplifies the likelihood of poor academic performance among medical students [13, 14]. Such manifestations are attributed to the burdensome academic demands, nocturnal clinical shifts, and protracted periods of nighttime study [15]. Similarly, studies have indicated that the prevalence of daytime sleepiness is estimated at 45% among dental students in Malaysia [16] and 11% among Turkish nursing students [17]. Contrastingly, it has been demonstrated that approximately 17% of a cohort comprising 114 physiotherapy students in Pakistan exhibited mild to moderate levels of diurnal sleepiness, while approximately 72% reported severe excessive daytime sleepiness [18]. Subsequent studies have elucidated that the duration of sleep preceding an examination emerges as a principal predictor of academic achievement among students, with those obtaining more than 6 h of sleep the night before an exam demonstrating markedly superior test scores compared to their counterparts with lesser sleep durations [19, 20]. Bahammam et al. underscored the potential deleterious repercussions of diminished nocturnal sleep on the academic attainment of medical students [21].

This study has considerable significance as it promises to substantially augment comprehension regarding the ramifications of EDS on learning progress, thereby prompting educational institutions to implement workshops and medical interventions aimed at enhancing students' academic performance. Despite numerous studies examining the prevalence of EDS and its implications on academic achievement among undergraduate students in healthcare disciplines globally [13, 16, 17], this study represents the inaugural endeavor to evaluate the prevalence of EDS and its impact on academic performance among undergraduate RT students in Saudi Arabia.

2 Methods

2.1 Study design

A cross-sectional online survey was created and distributed between the 5th of January and 30th of March 2023 through Survey Monkey.

2.2 Questionnaire

Our questionnaire was modified and adapted from previous questionnaires that were used to assess academic performance and excessive daytime sleepiness (EDS) [22, 23]. A multidisciplinary expert panel with interest in education and respiratory medicine have ensure the questionnaire was structured to meet the study objectives. Content and face

validity were assessed after piloting the questionnaire to 20 RT students who were excluded from the main study. The questionnaire was composed of four sections and consisted of 26 questions as follows:

- Sect. 1 consisted of six questions requesting demographic information: gender, age, smoking status, geographic location, academic year and university sector.
- Sect. 2 consisted of four questions that evaluate academic performance by using the cumulative grade point average (GPA), which is usually between >0.01 and 5.00, the number of days absent, academic warnings and the usual number of hours spent studying per week.
- Sect. 3 consisted of eight questions that assessed sleep patterns during a typical school week, nights and mornings before examinations, sleep hours, and how often students feel sleepy during class.
- Sect. 4 consisted of eight questions that assessed EDS by using the Epworth sleepiness scale (ESS), which is an accurate, validated questionnaire to measure EDS [22].

The ESS consists of eight parts representing various situations and daily activities, using a four-point scale where 0 = never falls asleep and 3 = high chance of falling asleep. The overall ESS score is a measure of how easily people typically fall asleep under given circumstances.

The total score ranges between 0 and 24, with 10 being the maximum normal score in healthy persons [24]. For the Epworth sleepiness scale (ESS) interpretation, a score between zero and ten is considered normal, a score between 11 and 12 is considered mild excessive daytime sleepiness, a score between 13 and 15 is considered moderate excessive daytime sleepiness, and a score between 16 and 24 is considered severe excessive daytime sleepiness.

2.3 Data collection and sampling

A convenience sampling technique was utilized in this study. The survey was distributed to 1,500 RT students in the Kingdom of Saudi Arabia through the WhatsApp platform. The survey link was sent to the directors of all RT programs across the country, who then shared it with their respective student groups via private WhatsApp channels. RT students currently enrolled in a Saudi university were the primary target population. We aimed to minimize recall bias by distributing the survey immediately after the examination period, ensuring that participants' responses regarding academic performance were recent and accurately reflected their most recent exam experience. Before starting the survey, a consent statement was presented along with information about the research and the contact details of the chief investigator. Each participant was required to agree to the following consent statement before proceeding: "Do you voluntarily agree to participate in this study and give your consent to your anonymous data being used for research purposes?" Duplication was avoided by allowing participants to access the survey link only once. The estimated time to complete the survey was between 4 to 5 mins.

2.4 Sample size

According to the World Health Organization for the prevalence study, the minimal sample size required for the prevalence study is 385 participants from each study population, with a confidence interval of 95%, standard deviation of 0.5, and margin of error of 5% [25].

2.5 Ethical approval

Ethical approval for this study was granted by the Research Ethics Committee at Batterjee Medical College before the study commenced (Reference No. RES-2022-0078). The study adhered to the ethical principles outlined in the Declaration of Helsinki. Participation was entirely voluntary, and informed consent was obtained from all participants before they proceeded with the survey. The study objectives, potential benefits, and the right to withdraw at any time were clearly communicated to ensure informed decision-making. To protect participant confidentiality, all responses were anonymized, and no personally identifiable information was collected. Data were securely stored and accessed only by authorized researchers in compliance with ethical guidelines.

2.6 Statistical analysis

Data were organized using Microsoft Excel and analyzed using SPSS version 28 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as frequencies and percentages. The prevalence of EDS was calculated with corresponding 95% confidence intervals. To assess associations between variables and EDS, Pearson's Chi-square test was used for categorical variables. For the continuous variable such as age, the Shapiro–Wilk test was used to assess normality, and due to its non-normal distribution, age was reported as median and interquartile range (IQR) and compared between groups using the Mann–Whitney U test. Independent samples t-test and one-way ANOVA were employed to compare EDS scores across different categorical groups. For inferential analysis, binary logistic regression was conducted after categorizing RT students into two groups: normal and EDS (including mild, moderate, and severe cases). Variables with p-values < 0.05 or approaching significance (< 0.25) in the univariate analysis were included in a multivariate logistic regression model to adjust for potential confounders. A p-value of < 0.05 was considered statistically significant.

3 Results

3.1 Sociodemographic characteristics

Out of the 1,500 RT students invited to participate, a total of 925 students from various universities across Saudi Arabia completed the survey, yielding a response rate of 61.7%. More than half of the RT students (502, or 54.27%) were male with a median age of 21 years (IQR = 20–22). The geographic distribution shows the largest proportion from the Southern region (29.95%), followed by the Northern (22.59%) and Western (21.41%) regions. Smoking status indicates that 75.24% of participants are non-smokers, while 9.30% are ex-smokers and 15.46% are current smokers. The majority of students (70.38%) have a cumulative GPA between 4.00–5.00, and most are enrolled in governmental universities (74.16%). The academic year distribution is fairly even, with 30.27% in their third year, 24.97% in their fourth year, and 25.83% in internships. In terms of attendance, 34.92% had 1–2 days of absence in the last semester. Academic warnings were low, with 72.11% reporting no warnings. Studying habits vary, with 31.35% studying 4–6 h per week. A majority (41.73%) take 1–3 naps per week, and the bedtime distribution suggests that most students go to bed between 12:01 AM–2:00 AM (45.51%). Sleep patterns show that 56.65% sleep 4–6 h per night. The data on exam preparation indicates that nearly half of the participants (48.32%) wake up earlier than usual before exams. As for their sleep habits on the night before an exam, 37.41% sleep 1–3 h, and 39.35% sleep 4–6 h. During the school week, a notable portion (36.86%) feels tired upon waking up, and 42.81% report feeling sleepy during the daytime. Finally, 39.03% experience excessive sleepiness during class time.

Significant associations with EDS were found for geographic location ($p < 0.001$), smoking ($p < 0.001$), university sector ($p = 0.003$), absence during the last semester ($p = 0.007$), academic warnings ($p < 0.001$), number of naps per week ($p < 0.001$), and excessive sleepiness during class ($p < 0.001$). Full sociodemographic, academic and sleep pattern descriptive data are presented in Table 1.

3.2 The prevalence of EDS among RT students

The prevalence of EDS among RT students was 32% (95% CI: 23% – 35%). The overall mean ESS score was 8.31 ± 4.4 , indicating a normal level of EDS among RT students. Data from the ESS questionnaire indicated that 138 (14.9%) experienced mild EDS (male: 69 and female: 69), 114 (12.3%) experienced moderate EDS (male: 66 and female: 48), and 45 (4.9%) experienced severe EDS (male: 26 and female: 19). Table 2

3.3 Comparison of ESS scores with sociodemographic, academic, sleep pattern variables among RT students.

The overall mean ESS score among RT students was 8.31 ± 4.4 . There were no statistically significant differences in ESS scores between males and females ($p = 0.092$). However, geographic location significantly influenced ESS scores, with students from the Northern region reporting the highest levels of daytime sleepiness (10.28 ± 3.6 ; $p = 0.006$). Smoking

Table 1 Demographic, academic and sleep pattern data of RT students (n=925)

Demographics	Frequency (%), median (IQR)	P value
Gender n (%)		
Female	423 (45.73%)	0.058
Male	502 (54.27%)	
Age (Median + IQR)	21 (IQR = 20–22)	0.342
Geographic location n (%)		
Southern region	277 (29.95%)	< 0.001
Northern region	209 (22.59%)	
Western region	198 (21.41%)	
Central region	185 (20.00%)	
Eastern region	56 (6.05%)	
Smoking status n (%)		
Non smoker	696 (75.24%)	< 0.001
Ex-smoker	86 (9.30%)	
Current smoker	143 (15.46%)	
Cumulative GPA n (%)		
< 2.00	4 (0.43%)	0.062
2.00–2.99	55 (5.95%)	
3.00–3.99	215 (23.24%)	
4.00–5.00	651 (70.38%)	
University sector n (%)		
Governmental	686 (74.16%)	0.003
Private	239 (25.84%)	
Academic year n (%)		
Second year	175 (18.92%)	0.749
Third year	280 (30.27%)	
Fourth year	231 (24.97%)	
Internship	239 (25.83%)	
Absence during last semester n (%)		
No absences	287 (31.03%)	0.007
1–2 days	323 (34.92%)	
3–4 days	204 (22.05%)	
≥ 5 days	111 (12.00%)	
Academic warnings n (%)		
No warning	667 (72.11%)	< 0.001
1 to 3 warnings	244 (26.38%)	
> 3 warnings	14 (1.51%)	
Hours of studying per week n (%)		
1–3 h	230 (24.86%)	0.224
4–6 h	290 (31.35%)	
7–9 h	200 (21.62%)	
> 9 h	205 (22.17%)	
Number of naps per week n (%)		
0 nap	340 (36.76%)	< 0.001
1 to 3 naps	386 (41.73%)	
≥ 4 naps	199 (21.51%)	
Time to go to bed n (%)		
Between 8:00PM–10:00PM	89 (9.62%)	0.231
Between 10:01PM–12:00am	273 (29.51%)	
Between 12:01 AM–2:00AM	421 (45.51%)	
After 2:01AM	142 (15.36%)	
Hours of sleeping per night n (%)		

Table 1 (continued)

Demographics	Frequency (%), median (IQR)	P value
1–3 h	90 (9.73%)	0.540
4–6 h	524 (56.65%)	
7–9 h	266 (28.76%)	
> 9 h	45 (4.86%)	
Waking up before the exam earlier than usual n (%)		
Always	447 (48.32%)	< 0.001
Often	166 (17.95%)	
Sometimes	205 (22.16%)	
Rarely	68 (7.35%)	
Never	39 (4.22%)	
Sleeping hours before the night of exam n (%)		
Don't sleep	131 (14.16%)	0.111
1–3 h	346 (37.41%)	
4–6 h	364 (39.35%)	
7–9 h	78 (8.43%)	
> 9 h	6 (0.65%)	
Feel tired when waking up during school week n (%)		
Always	218 (23.57%)	0.075
Often	259 (28.00%)	
Sometimes	341 (36.86%)	
Rarely	84 (9.08%)	
Never	23 (2.49%)	
Feel sleepy during daytime School week. n (%)		
Always	120 (12.97%)	0.139
Often	249 (26.92%)	
Sometimes	396 (42.81%)	
Rarely	132 (14.27%)	
Never	28 (3.03%)	
Excessively feel sleepy during class time n (%)		
Always	88 (9.51%)	< 0.001
Often	188 (20.32%)	
Sometimes	361 (39.03%)	
Rarely	233 (25.19%)	
Never	55 (5.95%)	

Data are presented as the frequency and percentage or median + interquartile range (IQR)

Table 2 Prevalence and severity of daytime sleepiness among RT students (n = 925)

Severity of Daytime Sleepiness	Frequency (%)
Normal	628 (67.9%)
Mild	138 (14.9%)
Moderate	114 (12.3%)
Severe	45 (4.9%)

Data are presented as frequencies and percentages

status was also associated with ESS, as current smokers had the highest mean score (9.32 ± 4.8 ; $p < 0.001$). University sector showed a significant difference, with students in private universities reporting higher ESS scores (8.84 ± 4.5) compared to those in governmental institutions (8.13 ± 4.3 ; $p = 0.030$). Although cumulative GPA approached significance ($p = 0.054$), academic warnings were strongly associated with increased ESS scores, especially among those with more than three warnings (12.50 ± 6.3 ; $p < 0.001$). Students with higher absence frequency (≥ 5 days) also had significantly elevated ESS

Table 3 Comparison of ESS scores with sociodemographic, sleep pattern and academic performance factors among RT students

Variables	N	Mean ($\pm$ SD)	P value
Overall ESS	925	8.31 (4.4)	
Gender			
Female	502	7.76 (4.3)	0.092
Male	423	7.99 (4.4)	
Geographic location			
Southern region	209	7.92 (4.5)	0.006
Northern region	56	10.28 (3.6)	
Western region	198	8.01 (4.7)	
Central region	185	8.46 (4.3)	
Eastern region	277	8.31 (4.1)	
Smoking status			
Non smoker	696	8.23 (4.2)	< 0.001
Ex-smoker	86	8.91 (4.4)	
Current smoker	143	9.32 (4.8)	
Cumulative GPA			
< 2.00	4	8.65 (4.7)	0.054
2.00–2.99	55	8.44 (4.4)	
3.00–3.99	215	8.31 (4.5)	
4.00–5.00	651	8.03 (4.2)	
University sector			
Governmental	686	8.13 (4.3)	0.030
Private	239	8.84 (4.5)	
Academic year			
Second year	175	8.25 (4.2)	0.870
Third year	280	8.42 (4.2)	
Fourth year	231	8.26 (4.5)	
Internship	239	8.21 (4.3)	
Absence during last semester			
No absences	287	8.01 (4.4)	0.004
1–2 days	323	7.87 (4.2)	
3–4 days	204	9.12 (4.1)	
$\geq$ 5 days	111	9.51 (5.2)	
Academic warnings			
No warning	667	7.93 (4.3)	< 0.001
1 to 3 warnings	244	9.69 (4.0)	
> 3 warnings	14	12.50 (6.3)	
Hours of studying per week			
1–3 h	230	7.83 (4.5)	0.091
4–6 h	290	8.37 (4.1)	
7–9 h	200	8.88 (4.3)	
> 9 h	205	8.20 (4.5)	
Number of naps per week			
0 nap	340	6.69 (4.3)	< 0.001
1 to 3 naps	386	8.52 (3.8)	
$\geq$ 4 naps	199	12.33 (4.1)	
Time to go to bed			
Between 8:00PM -10:00PM	89	8.62 (4.7)	0.264
Between 10:01PM -12:00am	273	8.25 (4.4)	
Between 12:01 AM -2:00AM	421	8.09 (4.6)	
After 2:01AM	142	8.88 (4.3)	
Hours of sleeping per night			

Table 3 (continued)

Variables	N	Mean (± SD)	P value
1–3 h	90	8.50 (4.1)	0.098
4–6 h	524	8.43 (4.2)	
7–9 h	266	7.83 (4.6)	
> 9 h	45	9.33 (5.0)	
Waking up before the exam earlier than usual			
Always	447	7.83 (4.3)	< 0.001
Often	166	8.15 (4.3)	
Sometimes	205	8.61 (4.2)	
Rarely	68	9.84 (4.5)	
Never	39	10.20 (4.9)	
Sleeping hours before the night of exam			
Don't sleep	131	9.78 (4.6)	0.003
1–3 h	346	8.69 (3.8)	
4–6 h	364	7.92 (4.5)	
7–9 h	78	7.99 (5.2)	
> 9 h	6	8.32 (5.4)	
Feel tired when waking up during school week			
Always	218	9.03 (4.2)	0.026
Often	259	8.40 (4.0)	
Sometimes	341	7.80 (4.9)	
Rarely	84	8.10 (6.6)	
Feel sleepy during daytime School week			
Always	120	8.71 (4.4)	0.004
Often	249	8.44 (3.7)	
Sometimes	396	8.53 (4.2)	
Rarely	132	6.95 (4.7)	
Never	28	8.71 (4.3)	
Excessively feel sleepy during class time			
Always	88	9.51 (4.8)	< 0.001
Often	188	8.70 (4.0)	
Sometimes	361	8.65 (4.2)	
Rarely	233	7.27 (4.0)	
Never	55	7.24 (6.2)	

EDS Excessive Daytime Sleepiness, GPA Grade Point Average

scores (9.51 ± 5.2 ; $p = 0.004$). Napping habits were a strong predictor of EDS, with those taking ≥ 4 naps per week scoring significantly higher (12.33 ± 4.1 ; $p < 0.001$). Sleep deprivation before exams was also associated with increased EDS; students who did not sleep the night before an exam reported the highest scores (9.78 ± 4.6 ; $p = 0.003$). Feelings of tiredness upon waking ($p = 0.026$), daytime sleepiness during the school week ($p = 0.004$), and excessive sleepiness during class time ($p < 0.001$) were all significantly associated with higher ESS scores. Other factors such as academic year, study hours, bedtime, and total sleep duration per night did not show significant associations with EDS. Table 3

3.4 Association of sociodemographic, sleep pattern and academic performance factors with EDS among RT students

The binary logistic regression analysis revealed that RT students who currently smoked were three times more likely to experience EDS than RT students who did not smoke [(OR): 3.28 (1.95–5.54); $p < 0.001$]. Similarly, RT students who were ex-smokers were almost three times more likely to experience EDS than RT students who did not smoke [(OR): 2.61 (1.35–5.07); $p = 0.004$]. RT students who reported being absent five or more days in the last semester were almost twice likely to experience EDS than RT students who reported no absence days [(OR): 1.48 (1.02–2.15); $p = 0.038$]. RT

students who received one to three academic warnings were almost two times more likely to experience EDS than RT students who had received no academic warning [(OR): 1.78 (1.31–2.42); $p < 0.001$]. RT students who had received more than three academic warnings were six times more likely to experience EDS than RT students who had received no academic warnings [(OR): 6.4 (1.98–20.71); $p = 0.002$]. RT students who reported at a private university or college were almost twice as likely to experience EDS compared to RT students who reported studying at a governmental university or college [(OR): 1.6 (1.16–2.14); $p = 0.003$]. RT students who took one to three naps per week were seven times more likely to experience EDS than RT students who did not take naps [(OR): 7.2 (2.06–25.54); $p = 0.002$]. RT students who took four or more naps per week were 15 times more likely to experience EDS than RT students who did not take naps [(OR): 15.2 (6.94–33.35); $p < 0.001$]. RT students who did not sleep the night before an exam were 11 times more likely to experience EDS than RT students who reported sleeping more than nine hours the night before an exam [(OR): 11.3 (1.28–100.52); $p < 0.029$]. Table 4

A multivariate logistic regression model was conducted including all significant predictors from the bivariate analyses. The model explained 13.7% (Cox & Snell R^2) to 19.2% (Nagelkerke R^2) of the variance in EDS. The Hosmer–Lemeshow test indicated a good model fit ($\chi^2(8) = 3.86$, $p = 0.870$), suggesting that the model adequately fits the data. After adjusting for other factors, smoking status showed a significant association, with current smokers having higher odds compared to non-smokers [(OR): 2.8 (1.58–4.62); $p = 0.003$], while former smokers also demonstrated increased odds [(OR): 1.9 (0.87–3.77); $p = 0.031$]. Regarding academic performance, participants with more than three academic warnings had significantly higher odds [(OR): 5.0 (1.25–20.23); $p = 0.023$], and those with one to three warnings showed a trend toward significance [(OR): 1.7 (0.98–3.02); $p = 0.059$]. Additionally, napping frequency was a strong predictor; individuals who took 1–3 naps per week had increased odds [(OR): 4.5 (1.09–18.97); $p = 0.038$], and those who napped ≥ 4 times per week had the highest odds [(OR): 11.5 (4.94–26.72); $p < 0.001$]. Other variables, including university sector, class absence, and lack of sleep before exams, were not significantly associated with EDS in the multivariate model (all $p > 0.05$). Table 5

Table 4 Binary logistic regression models of sociodemographic, sleep pattern and academic performance factors associated with EDS among RT students

Descriptor	OR (95% CI)	P value
Smoking Status		
Non smoke	1	
Former smoker	2.6 (1.35 to 5.07)	0.004
Current smoker	3.3 (1.95 to 5.54)	< 0.001
University sector		
Governmental	1	
Private	1.6 (1.16 to 2.15)	0.003
Absence during last semester		
No absences	1	
≥ 5 days	1.5 (1.02 to 2.15)	0.038
Academic warnings n (%)		
No warning	1	
1 to 3 warnings	1.8 (1.31 to 2.42)	< 0.001
> 3 warnings	6.4 (1.99 to 20.71)	0.002
Number of naps per week		
0 nap	1	0.002
1 to 3 naps	7.2 (2.06 to 25.54)	< 0.001
≥ 4 naps	15.2 (6.94 to 33.35)	
Sleeping hours before the night of exam		
> 9 h	1	
Did not sleep	11.4 (1.29 to 100.52)	0.029

CI confidence interval, OR odds ratio

Table 5 Multivariate logistic regression models of sociodemographic, sleep pattern and academic performance factors associated with EDS among RT students

Descriptor	OR (95% CI)	P value
Smoking Status		
Non smoke	1	
Former smoker	1.9 (0.87 to 3.77)	0.031
Current smoker	2.8 (1.58 to 4.62)	0.003
University sector		
Governmental	1	
Private	1.0 (0.70 to 1.46)	0.958
Academic warnings n (%)		
No warning	1	
1 to 3 warnings	1.7 (0.98 to 3.02)	0.059
> 3 warnings	5.0 (1.25 to 20.23)	0.023
Number of naps per week		
0 nap	1	0.038
1 to 3 naps	4.5 (1.09 to 18.97)	< 0.001
≥ 4 naps	11.5 (4.94 to 26.72)	

CI confidence interval, OR odds ratio

4 Discussion

To the best of our knowledge, this is the first study to investigate the prevalence of EDS and its impact on the academic performance of undergraduate RT students in the Kingdom of Saudi Arabia. Our study findings revealed that EDS existed among RT students in Saudi Arabia, although the majority reported a normal level of EDS on the ESS. However, the ESS scores were significantly higher among students who were current or former smokers, had absences in the previous semester, had received academic warnings, took daytime naps during a typical school week, slept more than nine hours the night before an exam, or were attending a private university or college.

Our study findings indicated that the overall prevalence of EDS among RT students was approximately 32%, while the remaining 67.9% reported normal levels of EDS. These findings are consistent with previous pertinent studies conducted on students in other health disciplines worldwide. Among medical students, the prevalence rate of DTS was 29% in India, 34% in Jordan, 37% in Morocco, 37–38% in Saudi Arabia, and 39% in Brazil [26–31]. However, other studies found that the incidence rate of EDS among medical students was relatively high, reaching 68% in Sudan and 41–45% in Pakistan [14, 32, 33]. Additionally, the proportion of dental students' exposure to EDS was 45% in Malaysia and almost 59% in Brazil [16, 34]. Furthermore, a cross-sectional study of 382 Turkish nursing students found that the prevalence of EDS was comparatively low, with just 10.5% of the respondents reporting having experienced EDS episodes [17]. Recently, Mehboob et al. illustrated that EDS was a common sleep-related symptom among 114 physiotherapy students in Pakistan. They observed EDS in 88.6% of the study participants, where the students had mild to moderate and severe sleepiness at 16.7% and 71.9%, respectively [18]. This extreme variation in the related study results is due to using a different interpretation approach on the ESS, which classified scores of seven or eight as mild to moderate EDS and scores of nine or more as severe EDS [18].

This study found that RT students who were current or former smokers were three times more likely than nonsmokers to experience EDS. The reason for this may be addiction to smoking tobacco, which is a potent stimulant that may adversely disrupt sleep patterns. Zhang et al. claim that nicotine consumption triggers the release of various neurotransmitters that suppress rapid eye movement sleep, consequently interrupting the sleep–wake cycle and raising the possibility of EDS [35]. Conversely, these outcomes were contradicted by a cross-sectional study among medical students in Pakistan showing that nonsmoking students reported a higher ESS score than their smoking counterparts [14]. However, pertinent studies in Saudi Arabia and India demonstrated a nonsignificant association between ESS scores and smoking status [26, 30]. These contradictory results may be due to the small sample size and the absence of smokers.

Moreover, our study revealed an exclusive finding, indicating that RT students attending a private university or college were almost twice as likely to experience EDS compared to RT students who study at a government university or college, which can be due to working and studying simultaneously to cover tuition fees. This claim was corroborated

by a cross-sectional study of high school students in Brazil, which found that work was a significant predictor of sleepiness since employed students frequently endure insufficient sleep throughout the workweek, which may trigger EDS [36]. Furthermore, Chiang et al. concluded that undergraduate students may sacrifice a portion of their sleep time for work or study, which adversely compromises both the quality and quantity of their sleep [37].

In addition, it was observed that RT students who had been absent five or more days in the previous semester had an almost twice increased risk of experiencing EDS compared to those who did report no absence. As such, RT students who received one to three academic warnings were twice as likely, and those who received three or more academic warnings were six times more vulnerable than those who did not receive any academic warnings. These results can be attributed to stressful lifestyles in the academic environment and clinical setting. Abdulghani et al. claim that medical students are more susceptible to sleep disorders due to the enormous academic pressure that results in disturbed sleep patterns, insufficient sleep duration, and consequent EDS [24]. Moreover, Hershner and Chervin pointed out that EDS is problematic for college students, as it can worsen their GPA and raise the risk of academic failure [38]. According to Hysing et al., EDS contributed relatively to an increased likelihood of school absence and decreased productivity among Norwegian adults [39]. In a recent study conducted by Kayaba et al. on Japanese university students, EDS was significantly associated with remarkable dysfunction in academic performance, including absences, tardiness, and falling asleep during class [40].

The current study discovered that RT students who had EDS were more likely to take daytime naps than their peers who did not have EDS. These outcomes are analogous to those of a related study on undergraduate students in Palestine, which showed that 71% of the total respondents ($n = 400$) had EDS, and 58% reported that they took naps during the day at least once a week [41]. Likewise, Gemnani et al. demonstrated that daytime sleepiness was significantly associated with midday naps among medical students [14]. In addition, Lovato et al. indicated that the frequency of naps was relatively increased with EDS among university students in Australia, as they are accustomed to naps to reduce excessive sleepiness [42]. Additionally, prior studies showed that medical students' sleep-wake cycles were substantially correlated with shorter sleep duration, delayed sleep onset, and EDS, leading to daytime napping [41, 43].

In terms of sleep duration, our study revealed that RT students who did not sleep the night before an exam were 11 times more susceptible to experiencing EDS than RT students who reported sleeping more than nine hours the night before an exam. These results may be somewhat comparable to those of a recent study conducted by Alqudah et al. that observed that Jordanian medical and paramedical students who slept for longer than seven hours had significantly lower ESS scores than those who slept for less than six hours [27]. As such, Sameer et al. found a statistically significant relationship between ESS scores and sleep duration among medical students in Pakistan, where students who slept less than six hours per night were more vulnerable to encountering EDS [44]. In contrast, in a sizable sample of high school students in Brazil, sleep durations of eight to ten hours were significantly associated with reduced EDS, whereas sleep durations of less or more hours elevated the odds of EDS [45]. Nevertheless, pertinent studies in Saudi Arabia and Pakistan failed to detect a significant association between EDS and the number of hours of sleep [14, 30].

4.1 Strength and limitations

Our study is the first national investigation into the prevalence of EDS and its impact on academic performance among undergraduate RT students in Saudi Arabia. It benefits from a well-representative sample from diverse regions and both private and public universities, allowing for generalizable results. However, the cross-sectional design, convenience sampling, and reliance on self-reported data may introduce recall bias and limit accuracy. Subjective measures of sleepiness are less precise than objective tests like the multiple sleep latency test (MSLT) or maintenance of wakefulness test (MWT) [46]. Moreover, EDS may result from factors beyond academic burdens, such as sleep or psychiatric disorders, medications, and comorbid conditions, which were not evaluated. The study also lacks assessment of chronotype, a significant factor given the population's tendency for a serotone chronotype and challenges adapting to daily routines. Further research is needed to explore the causes of EDS and establish preventive measures to enhance the academic performance of RT students in Saudi Arabia.

5 Conclusion

EDS is prevalent among undergraduate RT students, with almost one-third experiencing EDS that required lifestyle modification or pharmacological intervention to mitigate EDS. RT students who were current or former smokers, took daytime naps during a typical school week, did not sleep the night before an exam or attended a private university or

college were more vulnerable to EDS. Individuals with EDS had low academic performance, which was represented by more absent days and academic warnings. Further studies are warranted to investigate the leading causes to EDS and to develop tailored interventions to mitigate the EDS impacts on student academic performance.

Acknowledgements None

Author contributions Conceptualization, MMA &AMA; Data curation, MMA, AHA, AMA; Formal analysis, MSM, RAS; Investigation, AAA, JSA; Methodology, AYN, HA; Project administration; JSA, SMA, MSM; Supervision, MMA, AMA; Validation, AAA, SMA; Writing original draft, AHA, SZA, AMA, RAA, AYN, HA; Writing – review & editing, All authors. The authors read and approved the final manuscript.

Funding None.

Data availability The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate Ethical approval for this study was granted by the Research Ethics Committee at Batterjee Medical College before the study commenced (Reference No. RES-2022–0078). All participants provided informed consent prior to participation. All methods were carried out in accordance with the principles of the Declaration of Helsinki.

Consent for publication Non applicable.

Competing interests The authors declare no competing interests.

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