frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 08 September 2022
DOI 10.3389/feduc.2022.982320

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Higher Education, a section of the journal Frontiers in Education

RECEIVED 30 June 2022
ACCEPTED 19 August 2022
PUBLISHED 08 September 2022

CITATION
Sofyana M, Wibowo RA and Agustiningsih D (2022) Wake-up time and academic performance of university students in Indonesia: A cross-sectional study. *Front. Educ.* 7:982320. doi: 10.3389/feduc.2022.982320

Wake-up time and academic performance of university students in Indonesia: A cross-sectional study

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Several studies have highlighted the link between sleep, learning, and memory. Strong evidence shows that sleep deprivation can affect a student's ability to learn and academic performance. While delayed sleep-wake phase disorder was prevalent among young adults, available evidence showed an inconclusive association between sleep times and academic performance in university students. Therefore, we conducted a cross-sectional study among university students in Indonesia to collect their sleep duration, bedtime, wake-up time, and academic performance. An analysis of 588 university students in Indonesia found that only 38.6% of students sufficiently slept, and their median bedtime and wake-up time was 11:30 pm and 5:30 am, respectively. Gender and wake-up time accounted for a 5.8% variation in academic performance (adjusted R^2 = 4.5%) after controlling for sleep duration, bedtime, body mass index, the field of study, batch year, and physical activity. Male had 0.116 [95% Confidence Interval (CI) −0.167 to −0.064] lower grade point average ($p < 0.001$) than female and students who wake up later had 0.077 (95% Confidence Interval 0.025 to 0.129) greater grade point average ($p = 0.004$) than students who wake-up earlier. The prevalence of sleep deprivation related to the delayed sleep-wake phase among university students in Indonesia was high. Since wake-up time was related to the increased grade point average, the university should consider developing sleep-friendly policies and interventions to improve their academic performance.

KEYWORDS

academic performance, wake-up time, sleep time, university student, young adult

Introduction

Becoming a university student at the end of the teenage period is a big step in education. In this transition process, many things are different from previous levels of education that require students' readiness to face differences and changes. Various forms of adaptation need to be developed in multiple situations in higher education. The transition period results will affect the next phase in college and work life when they become fully mature. Changes that occur can be in the form of personal, social, academic, or environmental (Liu et al., 2019). University students experienced sleep quantity, quality, and pattern changes during this transition period (Urner et al., 2009; Park et al., 2019; Park et al., 2020). Environmental (Godsell and White, 2019; Nosetti et al., 2021), psychosocial (Urrila et al., 2015), and biological factors (Bruce et al., 2017) underlie changes in adolescents' sleep and wake cycles. This could explain the tendency for these populations to experience sleep deprivation as they attempt to synchronize their naturally delayed schedules with school or work obligations (Crowley et al., 2007; Owens and Adolescent Sleep Working Group & Committee on Adolescence., 2014). Therefore, we must understand how sleep affects student performance to develop the best intervention and policies (Hershner, 2020).

Over more than a century, several studies have highlighted the relationship between sleep, learning, and memory (Maquet, 2001; Rasch and Born, 2013). The quality and quantity of sleep are closely related to student learning capacity and academic achievement. Sleep increases neurocognitive and academic performance if actively optimized. Moderate quality of evidence indicates that a sleep duration of 7 to 8 h is sufficient for maintaining health (Pilcher et al., 1997; Watson et al., 2015; Ohayon et al., 2017; Ross et al., 2020). On the contrary, when students are sleep deprived, it is often associated with poor declarative and procedural learning (Curcio et al., 2006). Insufficient sleep poses a number of essential and complicated risks in the adolescent population. The consequences of insufficient sleep range from inattention, impaired executive functioning, and poor academic performance (Owens and Weiss, 2017) to poor academic skills with self-assessment, including delayed academic progress and failed academic exams (Hayley et al., 2017).

A recent systematic review found that the most common sleep health characteristic studied in the student population was sleep duration (Bjørnnes et al., 2021), and much fewer studies have been devoted to sleep timing (e.g., bedtime/wake-up time) (Chaput et al., 2020). To this day, the relationship between sleep and school performance we found in the literature is not clear (Jalali et al., 2020). Gradisar et al.'s (2011) review of sleep patterns and problems during adolescence found that Asian teens went to bed later and slept less than European and American teens. However, most studies were from westernized countries (Bjørnnes et al., 2021). In Asia and Indonesia, most studies were conducted among students in a specific subject, such as medical (Datta et al., 2018; Jalali et al., 2020), pharmacist (Sari et al., 2017), dental (Elagra et al., 2016), midwifery (Khairiyah and Anjan, 2017), nursing (Olii et al., 2018), which has limited generalizability.

Few sleep studies discuss the relation between chronotype and academic achievement (Bjørnnes et al., 2021). Bedtime and waking times among students reflect external commitments (timing of sleep) and circadian preferences (times of day when students will be most alert). Evening chronotypes are generally associated with lower academic performance (Hershner, 2020). A longitudinal study suggested that starting classes later can improve academic performance (Lima et al., 2009). Similarly, a review by Wheaton et al. (2016) provides evidence that postponing the start of school time increases weekday sleep time in adolescents, primarily by delaying waking times. Although starting later may improve student wellbeing, the effect on academic achievement remains uncertain (Bjørnnes et al., 2021). Some evidence suggests a positive relationship between later school start times and academic achievement. However, this relationship is relatively weak and not universal. One of the reasons is grading, which is not standardized and varies by subject, teacher, and school (Wheaton et al., 2016). Therefore, our study aimed to understand how self-reported sleep of undergraduate students is related to academic performance with a standardized grading system.

Materials and methods

Study design and setting

An online cross-sectional survey approved by the Medical and Health Research Ethics Committee (MHREC) of the Faculty of Medicine, Public Health, and Nursing Universitas Gadjah Mada (UGM) (approval number: KE/FK/1066/EC/2020) was conducted during the second week of April 2021 (11–17 April) among undergraduate students of UGM, Yogyakarta, Indonesia a part of the ASEAN University Network Health Promoting Network (AUN-HPN) Physical Activity in College Students (PACS) Project (Rahman et al., 2022). We conducted the research in accordance with the ethical principles of the Declaration of Helsinki. The manuscript was written following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for cross-sectional studies (von Elm et al., 2008; **Supplementary Appendix 1**).

We conducted a cross-sectional study at UGM, a public university in Daerah Istimewa Yogyakarta Province, the largest public university in Indonesia, with 59,540 students in the second semester of the academic year 2020/2021 (Sekretariat Direktorat Jenderal Pendidikan Tinggi Kementerian Pendidikan dan Kebudayaan, 2020). Our study was conducted during a social activity restriction called Pemberlakuan Pembatasan

Kegiatan Masyarakat Berbasis Mikro (PPKM Mikro) during April-June 2021 in Java and Bali Island (Menteri Dalam Negeri, 2021). UGM was still not reopened the university yet during this period with only practical skills, and theses were allowed to be conducted on campus (Universitas Gadjah Mada, 2021). Convenient sampling was conducted during a holiday week after the midterm assignment through social media groups in each faculty.

Participants

The inclusion criteria of our study were undergraduate students who conveniently filled the survey. We will exclude students who failed to complete the questionnaire and postgraduate students. As a part of a larger study, we did not calculate an *a priori* sample size. However, a minimum sample size of 500 was suggested to derive statistics involving logistic regression to determine factors related to academic performance that can represent the parameters in the population (Bujang et al., 2018).

Outcome measures

Sleep patterns during a typical week were measured by asking participants' time to go to bed and time to wake up. The reliability of the sleep questionnaire was already examined in our unpublished study. Total sleep time was categorized based on the sleep guideline threshold (Ross et al., 2020). Bedtime and wake-up time was categorized based on median bedtime and wake-up time. Academic achievement was measured by asking participants' last grade point average. Participants' physical activity (PA) as one of the confounding factors (Chung et al., 2018; Wang and Bíró, 2021) was measured using the Global Physical Activity Questionnaire (GPAQ) with showcards (Bull et al., 2009) and then analyzed using the GPAQ Analysis Guide to categorize whether meeting the PA Guideline (World Health Organization [WHO], 2010). The questionnaire also contained demographic data which could influence academic achievement, including gender (Pirmohamed et al., 2017), height (Gorry, 2017), weight (Anderson and Good, 2017), batch year (Chen and Chen, 2019), and educational field (Trail et al., 2008). Body mass index (BMI) was calculated from reported height and weight and then categorized based on the WHO threshold for Asian and South Asian populations as underweight (<18.5), normoweight (18.5–22.9), overweight (23–24.9), and obese (≥ 25 kg) (World Health Organization, 2020). Students' fields of study were categorized into health science, non-health natural science, and social science. We also add a bogus item to minimize inattentive responses in the whole questionnaire. Students who wrongly answered the bogus item were excluded from the analysis.

Statistical analysis

We presented the mean of sleep duration and median of bedtime and wake-up time as the distribution of these two variables was skewed. Categorical variables include total sleep time (adequate sleep duration and inadequate sleep duration), bedtime (after the median bedtime and before the median bedtime), wake-up time (after the median wake-up time and before the median wake-up time), total weekly PA (adequate PA and inadequate PA), gender (female, male), BMI (normoweight, overweight, obese, underweight), batch year (first-year, second-year, third-year, fourth-year, fifth-year), and educational field (health science, non-health natural science, social science). Academic performance as a continuous variable was expressed as the mean and standard deviation. We calculated the odds ratio (OR) of insufficient sleep based on their bedtime and wake-up time category. A multiple regression model was used to explore the association between sleep patterns and academic performance by adjusting BMI, gender, total weekly PA, BMI, batch year, and educational field as confounders.

Results

There were sixty hundred and thirty-nine students who participated in the survey. We excluded 51 students because of the incomplete questionnaire, the wrong answer to the bogus question, and the implausible GPAQ value. We included five hundred and eighty-eight subjects in the analysis. Seventy-five percent of our samples were female. As reported by our previous publication, most of our sample studied non-health natural science (56%), had a normoweight (48%), lack of PA (53%), and were in their first year (43,9%) (Wibowo et al., 2022). Only 38.6% of our respondents had adequate sleep duration (**Table 1**). On a median, students went to bed at 11:30 pm (8:00 pm to 5:00 am) and woke up at 5:30 am (2:00 am to 2:00 pm). The students tended to go to bed after the median (51.2%) and woke up after the median (53.4%). We also found that students who woke up before the median wake-up time were more likely to experience insufficient sleep (OR = 4.823).

Overall, participants' mean sleep duration was 6 h 14 min [Standard deviation (SD) = 1 h 30 min]. Only 38.6% of students sufficiently slept. However, we found no significant correlation between academic performance with sleep duration ($p = 0.503$).

Determinants of academic performance

Multiple regression was conducted to predict academic performance indicated from self-reported grade point average from bedtime, wake-up time, and sleep duration by considering

TABLE 1 Participants' characteristics.

	N (%)
Batch year	
- First-year	258 (43.9%)
- Second-year	205 (34.9%)
- Third-year	109 (18.5%)
- Fourth-year	11 (1.9%)
- Fifth-year	5 (0.9%)
Sleep duration	
- Adequate sleep duration	227 (38.6%)
- Inadequate sleep duration	361 (61.4%)

the field of study, gender, BMI, PA level, and batch year. There was no evidence of multicollinearity, as assessed by tolerance values greater than 0.1, with the lowest value of 0.705. The multiple regression model statistically significantly predicted grade point average, $F_{(8,579)} = 4.425$, $p < 0.0001$, adj. $R^2 = 0.045$. Gender and wake-up time added statistically significant to the prediction of grade point average (**Table 2**). Male had a 0.116 lower predicted grade point average than females [95% Confidence Interval (CI) −0.167 to −0.064]. On the other hand, students who woke up after the median wake-up time had 0.077 higher predicted academic grades than students who woke up before the median wake-up time (95% CI 0.025 to 0.129).

Discussion

This study found that wake-up time after median was associated with better academic performance. Multiple linear regression revealed that the model accounts for 5,8% of the variance in academic performance. Students who woke up after their population median wake-up time also had a greater grade point average. The present result is well aligned with previous studies on the role of sleep on cognitive performance (Baert et al., 2015; Toscano-Hermoso et al., 2020). Similarly, this study complements previous studies that found that later wake-up times and daily start times enhanced students' performance (Edwards, 2012; Marx et al., 2017; Alfonsi et al., 2020). This study provides further evidence for a link between sleep and academic achievement of college students in Indonesia. Waking up later has been associated with a small increase in academic achievement, which may offset the almost similar negative effect of depression on academic achievement (Richardson et al., 2012). Therefore, research results like those presented in this study should be disseminated to schools, parents, and other stakeholders. Even the student may not realize the extent of the insufficient sleep problems, and this data may help persuade them that some action is necessary. We propose that the university provide social services in professional support to encounter sleep problems among students. Schools and universities cannot make evidence-based policy decisions without data. We recommend that education stakeholders take advantage of these findings and consider partnering with researchers to explore appropriate start times for schools or universities in Indonesia. The field still needs rigorous research as many questions remain unanswered. So further research is required, including controlled trials and more qualitative research to obtain baseline data on student sleep characteristics.

The present study also advances our understanding of the relationship between sleep chronotype and academic performance in online learning settings due to the COVID-19 pandemic. In contrast to our result, a study by Valladares et al. (2018) in face-to-face education revealed that students with higher GPAs and who exhibit better academic performance were morning and intermediate chronotypes. Online learning can enhance academic performance and reduce the problems eveningness students encounter when they try to follow the university's academic schedule early in the day (Horzum et al., 2014). Several studies showed that older and more mature adolescents like to do activities later than less mature and younger adolescents. Teenagers who prefer the evening phase experience a circadian phase shift (Crowley et al., 2007). They perform worse in the morning (Facer-Childs et al., 2018) but have better attention and alertness in the evening (Venkat et al., 2020).

Unlike a prior study (Raley et al., 2016; Okano et al., 2019), we did not find that sleep duration was associated with better academic performance. Our results are consistent with the results of several studies. Two previous studies using objective measurement showed that total sleep duration was not correlated with students' academic performance (Eliasson et al., 2010; King and Scullin, 2019). In accordance with the results of our study, Valic et al. (2014) found rather than with total sleep time duration, self-reported academic performance is associated with the timing of sleep and wakefulness.

The inconsistencies in the literature regarding the association between sleep and school performance could be mediated by the effect of psychological wellbeing, which was not controlled in either our study or previous studies (Eliasson et al., 2010; Valic et al., 2014; Raley et al., 2016; King and Scullin, 2019; Okano et al., 2019; Armand et al., 2021). The relationship between quantity and quality of sleep with academic performance was moderated by the psychological wellbeing formed both U-shaped and inverted U-shaped (Armand et al., 2021). These two relationship patterns showed that poor and good sleepers could get good or bad academic grades depending on their psychological wellbeing (Armand et al., 2021). Therefore, it could be suggested

TABLE 2 Multiple regression results for grade point average.

Grade point average	B	95% Confidence interval		SE B	β	*p*-value	R^2	Δ R^2
		Lower limit	Upper limit					
Model							0.058	0.045
Constant	3.499	3.322	3.677	0.090		0.000		
Field of study	0.029	−0.033	0.092	0.032	0.037	0.359		
Gender	−0.116	−0.167	−0.064	0.026	−0.181	0.000		
Body mass index	0.000	−0.018	0.018	0.009	0.001	0.984		
Physical activity level	−0.008	−0.053	0.037	0.023	−0.014	0.725		
Batch year	−0.005	−0.030	0.021	0.013	−0.014	0.725		
Bedtime	0.000	−0.51	0.051	0.026	0.000	0.996		
Wake-up time	0.077	0.025	0.129	0.026	0.139	0.004		
Sleep duration	0.018	−0.036	0.072	0.027	0.032	0.512		

Model = "Enter" methods in SPSS Statistics. B = unstandardized regression coefficient; SE B = standard error of the coefficient; β = standardized coefficient; R^2: coefficient of determination; AR^2 = adjusted R^2.

that future studies should consider psychological wellbeing in examining the correlation between sleep and academic performance.

We also could not show the influence of adequate PA participation and body mass index on academic performance. While moderate evidence showed a positive correlation between PA participation and academic performance in school-aged children (Erickson et al., 2019), the evidence among university students is still scarce. Two studies among university students also did not find a correlation between PA and academic achievement (Aweau et al., 2013; Bulqini et al., 2021). However, one cross-sectional study in Slovenia found that undergraduate students' academic achievement only correlated with the recommended amount of PA participation but no more correlated with PA participation for more than 4 h (Lipošek et al., 2019). The null findings from the two studies are similar to our research, which the categorization of PA participation could cause without considering a higher amount than WHO recommendation of PA participation. The curvilinear relation between PA and academic performance, which could be explained by the benefits effect of PA on cognitive function and a trade-off between time allocation for PA participation and studying, could suggest PA promotion among university students without forfeiting time for learning. Several studies indicated that obesity leads to impaired cerebral blood flow and insulin sensitivity which could impair cognitive function (Thota et al., 2017; Peng and Chen, 2020). Previous studies found inconclusive results regarding the relation between BMI and academic performance among university students (Agarwal et al., 2013; Franz and Feresu, 2013; Atare and Nkangude, 2014; Anderson and Good, 2017; Aleidi et al., 2020; Almarshad and Bhilal, 2020; Alhazmi et al., 2021). The inconclusive results could be caused by the incapability of BMI in differentiating fat and fat-free mass, which have a stronger correlation with cognitive function (Smith et al., 2011; Klimova et al., 2017). In addition, BMI among university students is also correlated with the other factors influencing academic performance, which were not controlled in previous studies, such as self-esteem and body satisfaction (Radwan et al., 2019; Alghawrien et al., 2020).

Consistent with some previous research, female students exhibit higher academic performance than male students (Dumais, 2002; Voyer and Voyer, 2014). Numerous factors may cause this difference; for example, women have better attitudes toward information and communication technologies (ICT), internet and computer use, better control over time, learning strategies, and effort than men. Social and cultural factors may also influence this difference. Depending on their child's gender, parents bring up differently, and this upbringing can affect a student's learning abilities, behavior, and habits toward school. Moreover, these differences in the treatment of the student are also taken into account by the teachers in the school, which affects the student's academic performance (Vargas-Ramos et al., 2021).

There are several limitations of the current study. First, the cross-sectional design limits the causal inference of sleep habits and academic performance. Longitudinal studies comprising objective measurement (Smith et al., 2018) should be conducted by considering several academic performance mediators that were not yet controlled in this study (Richardson et al., 2012), such as stress (Frazier et al., 2019), anxiety (Moreira de Sousa et al., 2018; Lateef Junaid et al., 2020), motivation (Wu et al., 2020), personality traits (Coenen et al., 2021), and eating behavior (Valladares et al., 2016). Establishing a causal relationship between sleep and academic performance will require experimental manipulations in randomized controlled trials. However, it is challenging to implement in a real educational environment where students think and care more about their grades

(Hasnain and Bhamani, 2014). Second, this study used subjective questionnaires, a method frequently used to measure sleep. However, assessing sleep with this method can have a disadvantage because sleep patterns can change daily (Shin et al., 2021). Therefore, an objective assessment of sleep patterns using an accelerometer is important for evaluating the sleep pattern (Krystal and Edinger, 2008; Smith et al., 2018; Zhu et al., 2019) of students in future longitudinal and experimental studies. Lastly, regularity in sleep patterns should also be examined in future studies since most previous studies indicated that greater sleep pattern variability was associated with adverse health outcomes (Okano et al., 2019). While our sample consisted of a very high proportion of female students, which might be caused by the nature of online-based surveys (Smith, 2008), our study still provided valuable insight because women are a vulnerable population to sleep disorders which should get more research attention. Women are more likely to have more severe symptoms of depression, trouble sleeping at night, and excessive daytime sleepiness. Women also have more difficulty concentrating and remembering things due to sleepiness or fatigue. Future research may need to consider the more heterogeneous remote data collection to avoid sampling bias. Future longitudinal studies using validated tools were also required to examine strong causal inferences between students' sleep habits and academic performance (Boccabella and Malouf, 2017).

Conclusion

Our results support the concept that most university students suffer from sleep deprivation. We provide apprehension into the impact of circadian rhythms and habitual sleep patterns and differences in student's academic performance. These findings may have implications for Indonesia's education policy to constantly find a way to minimize the negative effect of sleep deprivation and maximize academic performance gains in university students.

Data availability statement

The original contributions presented in this study are included in the article/**Supplementary material**, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Medical and Health Research Ethics Committee (MHREC) of the Faculty of Medicine, Public Health, and Nursing Universitas Gadjah Mada (UGM). The patients/participants provided their written informed consent to participate in this study.

Author contributions

MS: conceptualization, methodology, investigation, formal analysis, writing – original draft, and writing – review and editing. RW: conceptualization, methodology, project administration, formal analysis, funding acquisition, and writing – review and editing. DA: conceptualization, methodology, and supervision. All authors contributed to the article and approved the submitted version.

Funding

This work was supported by Direktorat Penelitian Universitas Gadjah Mada (Grant agreement number 2458/UN1/DITLIT/DIT-LIT/PT/2021). This funding source had no role in the design of this study and will not have any role during its execution, analyses, interpretation of the data, or decision to submit results.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2022.982320/full#supplementary-material

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