



Sleep quality of Chinese high school seniors before and after school reopened from quarantine: differences between commuter students and residential students

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Background: The sleep quality and duration of Chinese high school students, particularly those in their last year, are poor. The sleep patterns and quality of sleep differ between commuter students and residential students. However, there is currently little research that focuses on their sleep quality during the quarantine period due to COVID-19 with that after the quarantine was lifted. The purpose of this study is to explore the differences in sleep between commuter students and residential students, as well as to identify factors that are associated with their sleep quality.

Methods: A total of 274 Chinese high school seniors were surveyed before and after school reopened. The Chinese version of Pittsburgh Sleep Quality Index (PSQI) was used, and their demographic information was collected.

Results: Both commuter students and residential students had significantly higher PSQI scores [mean (M) =7.09, standard deviation (SD) =3.208] in the second survey compared to the first (M =5.73, SD =3.712), and their actual sleep time was significantly shorter in the second survey (M =5.67, SD =0.582) compared to the first (M =7.85, SD =1.738). The subjective sleep quality, sleep duration, and daytime dysfunction of both commuter and residential students worsened after the school reopened. In contrast, the sleep latency and sleep efficiency of commuter students improved after the school reopened, though the same result was not found for residential students.

Conclusions: These results reflect that the quarantine measures during the pandemic period benefited students' sleep quality. After the reopening of schools and the commencement of preparation for the national college entrance exam (Gaokao), the sleep quality and duration of Chinese high school seniors declined. Additionally, they reported feeling more tired and lacking in energy during the daytime. In cases where studying encroaches on the sleep time, residential students lose less of their sleep duration than commuter students, while commuter students have higher sleep efficiency although it may not be a good thing.

Keywords: Sleep quality; Chinese high school seniors; commuter students; residential students; COVID-19

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Introduction

Sleep of Chinese high school seniors

Sleep is crucial for humans, especially for adolescents (1,2). Poor sleep quality is associated with increased risks of injuries, hypertension, obesity, diabetes, and other health problems (3-5). The American Heart Association has included sleep quality in its assessment of future cardiovascular risk factors (6). Sleep habits play an important role in the prevention of cardiovascular diseases (7). Researchers have found that adolescents with sleep disorders have an increased likelihood of experiencing depressive symptoms (8,9). The American Academy of Sleep Medicine recommends that teens ages 13 to 18 get 8 to 10 hours of sleep a day (10). However, the sleep quality of Chinese high school students is poor. A meta-analysis showed that 26% of Chinese high school students suffer from sleep disorders (11). A survey showed that only 17.71% of high school students had good sleep quality and only 34.41% slept for more than 8 hours (5), with an even shorter sleep time for high school seniors (12). Poor sleep quality has also been reported among high school students in other countries.

High school senior year, also known as grade 12, is the last year of high school in China and also the year before the national college entrance exam, or the Gaokao. In China, the Gaokao is considered an important exam, which has a direct effect on students' future professional learning and career development. Therefore, preparing for the Gaokao is the paramount focus for Chinese high school students in grade 12. They face the heaviest academic workload, highest academic intensity, and strongest academic pressure, which increase as the Gaokao approaches (12,13).

Highlight box

Key findings

- School reopening led to decreased sleep quality. Commuter students had less sleep but good sleep efficiency.

What is known and what is new?

- Sleep quality of Chinese high school seniors differs before and after school reopened from COVID-19 quarantine. Commuting and residing on campus have different impacts on sleep quality.

What is the implication, and what should change now?

- Commuting or residing on campus have an impact on seniors' sleep quality.
- Seniors should choose their sleeping arrangements based on their individual circumstances.

Sleep time of most Chinese high school students is greatly reduced (12) as they usually wake up before 6:30 am and are not likely to go to bed before 11 pm (14,15). Students who need to prepare for the Gaokao are more likely to have sleep problems than other high school students (12). Their sleep quality is affected by various factors, including gender, diet, psychological state, academic pressure, etc. (16).

Governmental pandemic policies regarding education

Since the outbreak of the COVID-19 pandemic in 2019, the format of education in China has changed (17). During the comprehensive rollout of China's pandemic prevention and control policies, there were generally two ways for Chinese high school students to attend classes: all online classes at home, where neither teachers nor students would go to school, or attending classes at school, where both teachers and students would remain on the campus. On December 7, 2022, the government issued a notice (18) instructing schools to relax pandemic prevention and control, and the attendance of classes has gradually returned to normal in 2023. All students have returned to classrooms and can choose to live in dormitories or at home. However, the changes brought about by the pandemic affected the sleep quality and total sleep time of high school students (19,20). Then, with the return to normal schooling, their learning and daily life have once again changed, which has further impacted their sleep.

Commuter students and residential students

In Chinese high schools, student dormitories are generally provided, and high school students can choose to be commuter students or residential students based on their family situation and personal preferences (21). Residential students usually live in six- or eight-person dorms with bunk beds. A study found that 39.9% of Chinese commuter students walk to school, 15.9% ride bicycles, and 44.2% use public transport, a taxi, or a private vehicle (22). Chinese commuter students usually go home to sleep every day, while residential students typically return home once every 2 weeks and stay at home for only 1 day. The different lifestyles of commuter students and residential students can affect their health and psychological status (23). Although some studies have focused on the sleep quality of residential students (24,25). There is currently little research comparing the sleep quality of commuter students with that of residential students.

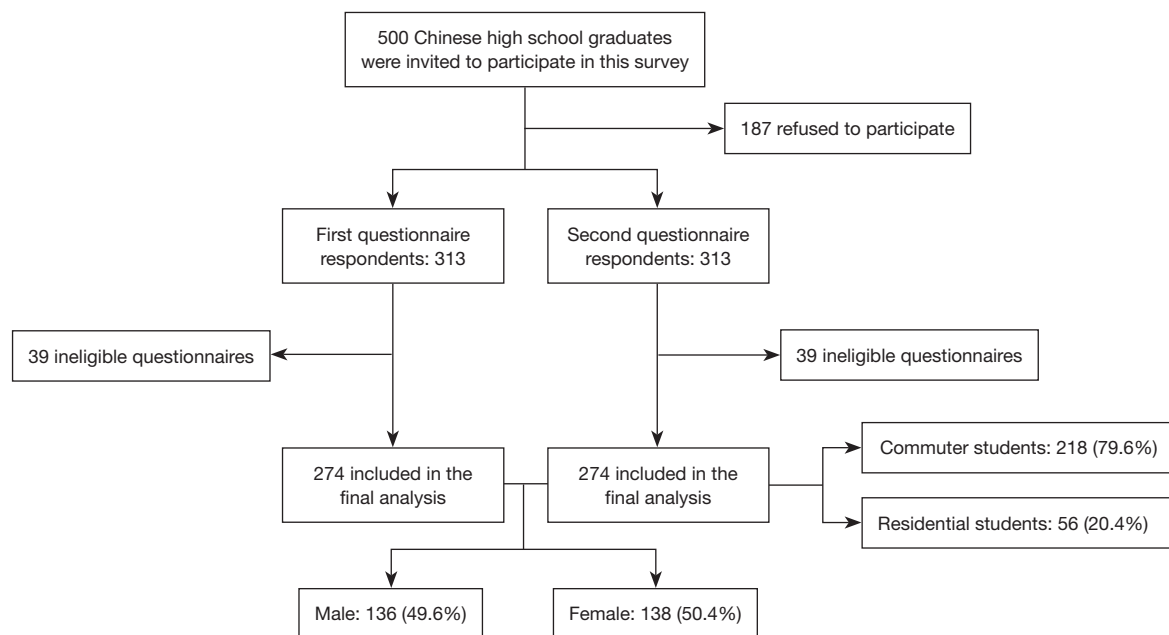


Figure 1 Flow of participants through the study.

Present study

This study aims to investigate the relationship between the concentrated isolation measures implemented during the pandemic and the sleep patterns of Chinese high school seniors upon the reopening of schools. The study particularly focuses on the differences between commuter students and residential students, emphasizing the significance of sleep for high school students and the impact of living arrangements on their sleep.

Methods

Participants

This study used a questionnaire to investigate the sleep of Chinese high school seniors. The comparison was made between the sleep quality of students who were quarantined in school due to the pandemic and their sleep quality after the quarantine was lifted. The study used convenience sampling and selected a high school located in an urban area in Jining City, Shandong Province, China. All participants had no reported significant medical illnesses, and did not miss a semester as required by the school. Students who declined to participate in the survey due to parental disagreement or other reasons (including have no interest, don't want to waste time, worry about risks, subjectively

reject the questionnaire) were excluded from the study. Before the survey, the researcher explained the purpose and significance of the survey to the teachers and students, and emphasized that the survey had nothing to do with studies, that the survey was anonymous and not compulsory. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Biomedical Research Ethics Committee of Shandong Provincial Hospital (No. 2022-392) and informed consent was obtained from all individual participants. The questionnaire was completed in the classroom and collected under the supervision of the main teacher and the researcher. The first survey began on December 20th, 2022, when all students were living in the school dormitory and had been strictly restricted from leaving the school for more than a month. The school was officially unsealed on January 8th, 2023, after which all teachers and students were free to enter and exit the campus. All participants received a unique identification code, which was composed of their class name combined with random numbers. This identification code was known only to the participants themselves and was used to link their responses in the two surveys. The second survey was conducted after the school had been unsealed for more than a month, and students could choose to commute or live on campus. A total of 313 Chinese high school seniors participated in the two sleep quality surveys (Figure 1).

Due to incomplete surveys or unreasonable answers, data from 39 individuals were excluded, leaving 548 completed questionnaires from 274 students for use in further analysis. The average age of the students was 17.66 years [standard deviation (SD) =0.573]. There were 136 male students (49.6%) and 138 female students (50.4%). In the first survey, all students lived on campus. In the second survey, 218 students were commuter students (79.6%) and 56 were residential students (20.4%).

Measures

Buysse *et al.* [1989] developed the Pittsburgh Sleep Quality Index (PSQI) (26), which has been widely used in various studies on sleep quality. In this study, the Chinese version of the PSQI was used, which has been shown to have good reliability and validity in studies on Chinese students (27,28). A study evaluated the validity and reliability of the Chinese version of the PSQI in nonclinical adolescents, and the results support the use of this tool to assess sleep quality in Chinese nonclinical adolescents (29). The PSQI is a scale used to assess participants' sleep quality over the past month. The scale consists of 19 self-rated (18 scored) and 5 otherwise-rated items. These items fall under 7 studied components, each with a range of 0–3 points. The sum of all component scores is the total score of the PSQI, which ranges from 0 to 21. A higher score indicates poorer sleep quality. Demographic information about the students was also collected, including gender, age, and commuter or residential status. In addition, students' daily commuting time was recorded (1 for 0–15 min, 2 for 16–30 min, 3 for 31–60 min, 4 for ≥ 61 min).

Statistical analysis

SPSS for Windows v. 26.0 (IBM, Armonk, NY, USA) was utilized for statistical analysis of the data. Descriptive statistics were used to analyze the demographic information and PSQI data, with the mean (*M*) (SD) used for continuous variables and percentages for categorical variables. An independent samples *t*-test was used to compare groups, such as males and females or commuter students and residential students. Meanwhile, a paired samples *t*-test was used to analyze the differences between the two surveys' results. All tests were two-tailed, and a *P* value ≤ 0.05 was considered statistically significant.

Results

Results of the first survey on sleep (before school reopened)

The results of PSQI score showed that the *M* was 5.73, and the SD was 3.712. There was no significant difference in sleep quality between males (*M* =5.77, SD =3.89) and females (*M* =5.69, SD =3.55), with *F*=2.123 and *P*=0.15. 21% of students got a PSQI score above 8, having fairly bad or very bad sleep. The average actual sleep time of high school seniors was 7.85 hours per day (SD =1.741), with no significant difference between males (*M* =7.15, SD =1.745) and females (*M* =8.47, SD =1.479). The biggest problem for high school seniors was sleep latency, and 57.2% of students experience difficulty falling asleep within 30 min at least once a week according to the results of question 5a. Subjective sleep quality was reported as very good for 32.8%, fairly good for 48.9%, fairly bad for 16.1%, and very bad for 2.2%, which is consistent with the results of the PSQI based on PSQI score: 0–3 very good, 4–8 fairly good, 9–16 fairly bad, 17+ very bad. Only 1.4% of students attempted to use medication for sleep. However, 77.4% of students had trouble staying awake, and 67.9% had trouble maintaining enthusiasm.

Results of the second survey on sleep (after school reopened)

The PSQI results showed that the *M* was 7.09 (SD =3.208). Female students (*M* =7.10, SD =2.587) had significantly higher PSQI scores than male students (*M* =7.07, SD =3.745), with *F*=8.714 and *P*=0.003. There was no significant difference in PSQI scores between commuter students (*M* =7.16, SD =3.319) and residential students (*M* =6.79, SD =2.742), with *F*=1.886 and *P*=0.17. The results showed that 29% of students had fairly bad or very bad sleep quality, and the average daily actual sleep time was 5.67 hours (SD =0.582). Male students (*M* =5.62, SD =0.645) had significantly less sleep time than female students (*M* =5.72, SD =0.509), with *F*=12.048 and *P*=0.001. Meanwhile, commuter students (*M* =5.61, SD =0.590) had significantly less sleep time than residential students (*M* =5.892, SD =0.493), with *F*=23.882 and *P*<0.001. The results also showed that 48.2% of students cannot fall asleep within 30 min at least once a week. The subjective sleep quality results (18.2% very good, 59.1% fairly good, 19.7% fairly bad, and 2.9% very bad) were consistent with the PSQI results. Only 4.4% of students attempted to use medication to induce

Table 1 Comparison of the seven components of sleep quality before and after school reopened for all students

Components	Before		After		P
	M	SD	M	SD	
Subjective sleep quality	0.8832	0.74682	1.0730	0.70201	0.002**
Sleep latency	1.7080	1.82839	1.2774	1.43596	0.002**
Sleep duration	0.3212	0.68403	1.3285	0.58189	<0.001**
Sleep efficiency	0.2701	0.64625	0.1533	0.41740	0.012*
Sleep disturbances	0.8686	0.61504	0.8905	0.61339	0.62
Use of sleeping medication	0.0365	0.30643	0.0949	0.48241	0.10
Daytime dysfunction	1.6423	1.07409	2.2701	0.94154	<0.001**

*, $P \leq 0.05$; **, $P \leq 0.01$. M, mean; SD, standard deviation.

Table 2 Comparison of the seven components of sleep quality before and after school reopened for commuter students

Components	Before		After		P
	M	SD	M	SD	
Subjective sleep quality	0.9541	0.74840	1.1009	0.71771	0.040*
Sleep latency	1.7248	1.78510	1.1560	1.44436	<0.001**
Sleep duration	0.3211	0.67722	1.3853	0.59037	<0.001**
Sleep efficiency	0.2569	0.62812	0.1560	0.43306	0.050*
Sleep disturbances	0.8807	0.66130	0.8991	0.60634	0.72
Use of sleeping medication	0.0459	0.34308	0.1193	0.53838	0.10
Daytime dysfunction	1.6881	1.09205	2.3486	0.91456	<0.001**

*, $P \leq 0.05$; **, $P \leq 0.01$. M, mean; SD, standard deviation.

sleep. According to the results of question 8, only 9.5% of students did not have trouble staying awake, 8% less than once a week, but 23.4% once or twice a week and 58.4% three or more times a week. 20.6% of students did not have a problem keeping up their enthusiasm, 17.5% had a very slight problem, 25.5% had somewhat of a problem and 41.6% had a very big problem according to the results of question 9.

Comparison of sleep before and after school reopened

Comparison of sleep for all students before and after school reopened

The second PSQI score ($M = 7.09$, $SD = 3.208$) was significantly higher than the first ($M = 5.73$, $SD = 3.712$), with $t_{(372)} = -4.879$ and $P < 0.001$. Furthermore, the second report of the actual sleep time ($M = 5.67$, $SD = 0.582$) was

significantly less than the first ($M = 7.85$, $SD = 1.738$), with $t_{(273)} = 19.502$ and $P < 0.001$. *Table 1* shows that the scores for subjective sleep quality, sleep duration, and daytime dysfunction were significantly higher in the second survey compared to the first, but the scores for sleep latency and sleep efficiency were significantly lower ($P \leq 0.05$).

Comparison of sleep for commuter students before and after school reopened

Commuter students had a significantly higher PSQI score in the second assessment ($M = 7.17$, $SD = 3.319$) compared to the first ($M = 5.87$, $SD = 3.807$), with $t_{(217)} = -3.996$ and $P < 0.001$. Furthermore, the actual sleep time in the second survey ($M = 5.61$, $SD = 0.590$) was significantly shorter than in the first ($M = 7.82$, $SD = 1.651$), with $t_{(217)} = 18.253$ and $P < 0.001$. *Table 2* shows that the subjective sleep quality, sleep duration, and daytime dysfunction scores for

Table 3 Comparison of the seven components of sleep quality before and after school reopened for residential students

Components	Before		After		P
	M	SD	M	SD	
Subjective sleep quality	0.6071	0.67900	0.9643	0.63143	0.001**
Sleep latency	1.6429	2.00389	1.7500	1.31079	0.753
Sleep duration	0.3214	0.71623	1.1071	0.49281	<0.001**
Sleep efficiency	0.3214	0.71623	0.1429	0.35309	0.105
Sleep disturbances	0.8214	0.38646	0.8571	0.64466	0.67
Use of sleeping medication	0 [†]	0	0 [†]	0	None
Daytime dysfunction	1.4643	0.99021	1.9643	0.99021	0.003**

[†], † could not be computed because the standard deviations of both groups were 0; **, P≤0.01. M, mean; SD, standard deviation.

commuter students were significantly higher in the second survey compared to the first, while the sleep latency and sleep efficiency scores were significantly lower ($P \leq 0.05$). The ratio of actual sleep to time in bed in the second survey ($M = 93.5\%$, $SD = 0.0726$) was higher than that in the first survey ($M = 92.1\%$, $SD = 0.1131$).

Comparison of sleep for residential students before and after school reopened

Residential students had a significantly higher PSQI score ($M = 6.79$, $SD = 2.742$) on the second assessment compared to the first ($M = 5.18$, $SD = 3.292$), with $t_{(55)} = -3.097$ and $P = 0.003$. The second assessment also showed a significant decrease in actual sleep time ($M = 5.89$, $SD = 0.493$) compared to the first ($M = 7.95$, $SD = 2.055$), with $t_{(55)} = 7.382$ and $P < 0.001$. None of the residential students reported using medication. *Table 3* shows that the second assessment scores for subjective sleep quality, sleep duration, and daytime dysfunction were significantly higher than the first assessment scores ($P \leq 0.05$).

Discussion

Chinese high school seniors had significantly better sleep quality and sleep duration when quarantined at school than after school reopened. The difference between the before and after PSQI scores was -1.36 (5.73 vs. 7.09), and the difference in actual sleep time was 2.18 h (7.85 vs. 5.67 h). Sleep duration is the third component of the PSQI (26), and its score had a difference between the before and after results of -1.01 (0.32 vs. 1.33), which was a key factor in the overall difference in PSQI score. A study found that sleeping for less than 6 hours is very dangerous (5), but Chinese high

school seniors only slept on average for 5.67 h after school reopened, which is lower than the recommended sleep time for high school students. There are multiple reasons for the significant decrease in sleep time. The sleep time and sleep quality of high school students improved during the pandemic period (19). The strict control during quarantine and the reduction in class time due to psychological health considerations ensured students' sleep time, which disappeared after school reopened. In addition, the second survey was conducted less than 3 months before the college entrance examination, meaning the school day started earlier than normal, which also led to a decrease in sleep time (2). Not only that, many studies have found that earlier school start times are not conducive to the control of negative emotions, attendance, concentration, and test scores (30-32). A further finding was that there was a significant difference in subjective sleep quality before and after school reopened, which matched the results of the PSQI. This indicates that students' perception of their sleep quality was relatively accurate, meaning they could truly feel the changes in sleep quality (33). Sleep latency is often highlighted as the most troublesome issue for students (34,35), but the results of this study revealed that it was somewhat alleviated after school reopened. Correspondingly, sleep efficiency also improved. However, the improvement in these two aspects may not have been positive or contributed to improving their daytime functioning. Commuting time reduces their sleep and study time, and they have to go to bed later and wake up earlier. As a result, they feel sleepier and fall asleep faster. Their fatigue and drowsiness had not been relieved (36), as reflected by the increased daytime dysfunction after school reopened. We do not recommend reducing the sleep time that high school students already do not get enough in

order to increase sleep efficiency. Before school reopened, there was no significant difference in sleep quality and sleep time between boys and girls. However, after school reopened, girls slept for longer than boys, though their sleep quality was poorer than that of boys. Previous studies also found that girls had longer sleep times (37) and poorer sleep quality (38,39). In the case of such intense study pressure and longer study time, the sleep of female students should be paid more attention. A final finding was that Chinese high school seniors rarely use medication to relieve their sleep problems. This is because, in China, people rarely seek medical help for sleep problems (40,41).

After school reopened, nearly 80% of students chose to go home to sleep. The reason for this may be that they prefer to spend time with their families, or they think that the living and sleeping environment at home is better. There was no significant difference in the PSQI score between commuter and residential students, but the sleep time of commuter students was significantly shorter than that of residential students. This was because commuter students spent more time on the road: all residential students had a commute time of 15 min or less, while commuter students necessarily traveled for longer. The levels of sleep latency and sleep efficiency of commuter students improved compared to before school reopened, while those of residential students did not. The shorter sleep time of commuter students compared to residential students made it easier for them to fall asleep. Furthermore, their sleeping environment was more conducive to sleep, with a personal bedroom, a more comfortable bed, better sound insulation (23). Although the proportion was not high, some commuter students did use medication to help with sleep, while students who continued to live on campus after school reopened did not report using medication in either survey. This difference was noted to have arisen because residential students had fewer opportunities than commuter students to communicate face-to-face with their parents (21), making it difficult for them to seek help from professionals.

This study has identified the changes in sleep quality of Chinese high school seniors by comparing a small sample's sleep before and after school reopened, and has compared commuter students to residential students. The implications derived from the discussed findings are multifaceted and hold significance for understanding the sleep patterns and factors influencing Chinese high school seniors, especially in the context of pandemic-related disruptions and the reopening of schools.

Firstly, the study highlights a substantial difference in sleep quality and duration for Chinese high school seniors between the period of concentrated isolation during the pandemic and after schools reopened. The observed decline in sleep quality and shorter sleep duration after reopening underscores the need for educational institutions and policymakers to consider the impact of changes in daily routines on students' sleep patterns. Secondly, the disparity in sleep quality and duration between commuter students and residential students emphasizes the importance of living arrangements as a contributing factor. Residential students have a longer sleep time, while going home to sleep can increase sleep efficiency although this is not necessarily a good thing. Recognizing these differences can aid in developing strategies to address the specific needs of both groups. The implications extend to the role of school start times and daily schedules. The study suggests that earlier school start times negatively affect sleep duration, which in turn influences students' daytime functioning. Thus, revisiting school start times and scheduling arrangements could have potential benefits for students' sleep and overall performance. Additionally, the findings suggest that female students' sleep patterns warrant particular attention due to the observed differences in sleep duration and quality between genders. Acknowledging these disparities and their potential impact on female students' well-being can lead to tailored interventions and support mechanisms.

This study underscores the need for comprehensive efforts to enhance sleep quality and duration among Chinese high school seniors. Addressing factors such as living arrangements, school start times, and gender-related differences can contribute to fostering healthier sleep patterns, ultimately improving students' academic performance, mental well-being, and overall quality of life. However, there were some methodological limitations. First, the findings are time-sensitive as the study was conducted during the COVID-19 pandemic, with inevitably affected students' sleep quality. Further research is needed on their sleep quality now that the study practices and lives of Chinese high school students have returned to normal. Second, the representativeness of the sample was limited as it was not possible to conduct large-scale sample selection during the pandemic. The high school seniors of the school that was sampled did not fully represent all Chinese high school students. Third, as another result of the pandemic, the sample size was inadequate, especially for residential students. Fourth, the research subjects were limited to high school seniors; future studies should aim to expand

the research subjects that are included to all three grades of high school and identify the differences between them. Finally, the PSQI is a scale designed for adults. Although some studies have used the Chinese version of the PSQI for sleep assessment in adolescents, targeted improvements may be necessary.

Conclusions

After school reopened and with the approach of the national college entrance exam, the sleep quality and duration of Chinese high school seniors significantly declined. This resulted in an increase in daytime dysfunction. Their subjective sleep quality was consistent with the overall score obtained from the PSQI, and the most common sleep problem experienced by Chinese high school seniors was an inability to fall asleep within 30 min. During the quarantine period, there was no significant difference in sleep quality between males and females. However, after school reopened, female students had poorer sleep quality than male students, despite sleeping for longer. Differences in sleep between commuter students and residential students were also observed after school reopened. Commuter students slept less than residential students, though their sleep latency and efficiency improved compared to when they were quarantined; in contrast, residential students did not show any improvement. A small number of commuter students reported using sleep medication, while residential students did not.

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Footnote

Data Sharing Statement: Available at <https://jphe.amegroups.com/article/view/10.21037/jphe-23-41/dss>

Peer Review File: Available at <https://jphe.amegroups.com/article/view/10.21037/jphe-23-41/prf>

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at <https://jphe.amegroups.com/article/view/10.21037/jphe-23-41/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all

aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Biomedical Research Ethics Committee of Shandong Provincial Hospital (No. 2022-392) and informed consent was obtained from all individual participants.

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