

# Unveiling the Sleep Crisis: Implications for Adolescent Health, Academic Performance and Policy Reform

Weng, Tsung-En John

E-mail: JohnWeng2222@gmail.com

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## Abstract

Sleep, a fundamental aspect of human life, remains a perplexing phenomenon despite its ubiquity. Spending nearly a third of our lives asleep, we still grapple with understanding its purpose and significance. This study delves into the complexities of adolescent sleep patterns, particularly among Taiwanese students, recognizing the critical role of sufficient sleep in mental well-being and academic performance. Through a multidimensional approach integrating literature review, expert interviews and empirical data analysis, we illuminate the alarming prevalence of inadequate sleep among adolescents globally, emphasizing its detrimental effects on various aspects of health and academic outcomes. Furthermore, we underscore the potential benefits of delaying school start times and advocate for policy changes to prioritize student well-being and academic success.

Keywords: sleep deprivation, health, mental health, school schedule, academic performance

## 1. Introduction

### I. Background & Motivation

Spending almost  $\frac{1}{3}$  of our entire lives sleeping, we could not give a definite answer on why we do it, and what it is for. Ever since the establishment of human civilization, sleep seems to be the most foolish biological phenomenon ever invented. When we sleep, we cannot work, eat, reproduce, or even protect ourselves. Then, what function does it serve? However, is it really due to sleep that serves no beneficial function, or is it due to society's apathy toward sleep that all scientific research resulted in vain? Yet, sleep has persisted. Throughout history, every aspect of humans or animals studied, all dates to sleep. Daily performance, mental health, and even drowsy driving-you name it. Sleep evolves with life itself on our planet. This simply implies the subsequent perseverance of sleep throughout human evolution means there are some magical things or astounding benefits sleep gives off while evolution itself did not make a spectacular blunder in conceiving of sleep.

Recognizing the crucial role of sufficient sleep in bolstering adolescents' mental well-being and academic performance, we delved into this issue, astutely realizing its pertinence to our lives and the gravity of its implications. As high school students, we observed that many of our peers are sleep-deprived, with almost all of them getting less than 8 hours of sleep. Consequently, we've noticed a pervasive sense of drowsiness in class, especially during the early periods, making it challenging to concentrate and start the day alertly. This observation underscores the gravity of recognizing these issues and advocating for change within our community.

### II. Research Purposes

This research wanted to highlight the trend of sleep habits of adolescents for Taiwanese students to illustrate the inadequacy of sleep time in schools. Alternatively, this research also wanted to point out the benefits sleep could give, where most school policies are conflicting with a good night sleep. Thus, underscoring the importance of having sufficient sleep, this study comes with providing the reason

behind inadequate sleeping and proving the causal relationship between a good night's sleep and its effect on mental health and academic achievements, as it is also a crucial step to persuade society to make changes in school start time. More importantly, this study also wanted to advocate for effective strategies to promote healthy sleep habits. This could be supported by illustrating how postponing school start time could provide more academic benefits, which includes providing a tangible and standardized school schedule for all schools to follow in Taiwan.

## 2. Literature Review

Currently, a multitude of studies already points out to the benefits of efficient sleep.

### 1. National Library of Medicine

The meta-analysis of randomized controlled trials (RCTs) investigating the relationship between sleep quality and mental health reveals significant findings. Across 65 trials involving 72 interventions and 8,608 participants, improving sleep quality led to notable improvements in mental health outcomes. Specifically, interventions targeting sleep improvement showed medium-sized effects on composite mental health, depression, anxiety, and rumination, with small-to-medium effects on stress and small effects on positive psychosis symptoms. Additionally, a dose-response relationship was observed, indicating that greater improvements in sleep quality correlated with greater enhancements in mental health. These improvements, expressed as a percentage, indicate approximately a 188% enhancement in composite mental health outcomes associated with the improvement in sleep quality. (Scott, 2021)

### 2. Science of Learning

The study revealed significant correlations between sleep measures and academic performance among 88 college students in an introductory chemistry class. Participants who went to bed and woke up earlier tended to have higher overall scores. Longer sleep duration, better sleep quality, and greater sleep consistency were associated with better academic performance, accounting for 24.44% of the variance in grades. (Okano, 2023)

### 3. Randomized Controlled Trial in Pediatrics

The study explored sleep patterns and their association with academic performance among student pharmacists at Auburn University's Harrison School of Pharmacy. It found that the majority of student pharmacists

obtained less than the recommended 7 hours of sleep per night, with even shorter sleep durations observed on nights before examinations. Longer sleep duration on the night prior to an examination was significantly associated with higher course grades and semester GPAs. These findings suggest that adequate sleep, especially before exams, is crucial for academic success among student pharmacists. (Zeek, 2015)

On the contrary, conventional studies also highlight the harms inadequate sleep could bring, as it is associated with various negative outcomes for adolescents.

### 4. Psychiatry Research

The study aimed to investigate the association between insufficient sleep and suicidal ideation among adolescents. It utilized data from the 2017 Youth Risk Behavior Survey (YRBS), which included 13,659 adolescents aged 14-18 from the United States. Suicidal ideation was measured based on whether participants had seriously considered attempting suicide in the past 12 months. Insufficient sleep was defined as getting less than 8 hours of sleep on an average school night.

Results indicated that 17.6% of adolescents experienced suicidal ideation, and 75.2% reported insufficient sleep. Factors associated with suicidal ideation included being female, being a sexual minority, experiencing traditional and cyberbullying, feeling sad or hopeless, being overweight, smoking cigarettes, drinking alcohol, using marijuana, and using illicit drugs. Additionally, physical inactivity was linked to a higher likelihood of suicidal ideation. (Baiden, 2023)

### 5. Healthline

Sleeping fewer than 7 hours per night increases the risk of obesity by 41%. Inadequate sleep impairs cognitive function, raising the likelihood of medical errors by up to 97%. Additionally, poor sleep quality elevates the risk of heart disease and type 2 diabetes. Mental health is also impacted, with sleep disturbances linked to depression. Furthermore, inadequate sleep compromises immune function, increasing susceptibility to infections. (Villalobos & Wilson, n.d.)

## 3. Research Methods

The research methodology employed for this study involved a multifaceted approach, integrating various data collection methods to provide a comprehensive analysis of adolescent sleep habits in Taiwan.

Firstly, online research was conducted to gather existing literature, academic studies, and statistical data related to sleep patterns, sleep hygiene, and the impact of sleep on mental health and academic performance.

Secondly, university professors specializing in fields of sleep were interviewed to gather expert insights and perspectives on adolescent sleep patterns and the factors influencing them. These interviews provided valuable qualitative data, allowing for a deeper understanding of the complex interplay between academic stress, extracurricular activities, employment, and biological factors affecting adolescents' sleep habits.

Finally, scholarly studies conducted by researchers in the field of sleep science and adolescent health were utilized to supplement the qualitative and theoretical insights obtained from online research and expert interviews. These studies provided empirical evidence and statistical analysis supporting the link between inadequate sleep and negative outcomes such as decreased cognitive function, impaired academic performance, and heightened risk of mental health issues among adolescents.

## 4. Analysis and Results

### I. Global Trend

The contemporary trend of sleeping habits presents a disturbing narrative. The World Health Organization has pointed to a 'global epidemic of sleeplessness' (throughout industrialized nations) with roughly two-thirds of adults sleeping less than 8 hours a night (Lyon, 2023). Figure 1 illustrates the inadequacy of sleep on a worldwide scale.



Figure 1 (Yardney, 2022)

More importantly, in a recent survey conducted among a sample of over 2000 Taiwanese high school students, more than 90% of junior and senior high school students fall short of the recommended sleep duration of 8 hours per night. A troubling 37% report obtaining only 5-6 hours of sleep, with an additional 12.6% admitting to receiving less than 5 hours of sleep each night. A comparative analysis with data from 2017 demonstrates a noteworthy deterioration in sleep patterns among this demographic. The percentage of junior high school students obtaining less than 5 hours of sleep has seen a doubling from 4.5% in 2017 to 9%, while those acquiring 5-6 hours of sleep have increased from 27% in 2017 to 30.1%. The recommendations set forth by the National Sleep Foundation in the United States further emphasize the gravity of this situation. According to their guidelines, children aged 6 to 13 should ideally secure 9-11 hours of sleep per night, while teenagers aged 14 to 17 should aim for 8-10 hours of sleep daily. Unfortunately, the findings from the survey starkly contrast with these benchmarks, indicating a substantial deficit in the sleep duration of Taiwanese students.

## II. Factors Contributing to Insufficient Sleep in Adolescents

### A. Activities, employment, and academic demands

Participation in extracurricular activities, employment, and academic demands compete for a time during an adolescent's day with each one potentially resulting in later bedtimes. Extracurricular activities can delay bedtime with evening tutors, meetings, or practices. The Child Welfare League Foundation (CWL, 2023) found that 59.8% of children and adolescents participate in after-school tutoring, with urban students exceeding 72.4%. Among them, nearly one-fourth (24.7%) attend tutoring almost every day (five days or more per week), and more than 63.8% stay in cram schools until 9:00 pm, with 23.1% staying until after 10:00 pm, and those teens reported significantly less total sleep time and significantly later bedtimes.

In addition to activities, many adolescents have after-school jobs. In one study, 58.7% of adolescents reported having a part-time job and 28.3% reported working 20 h/week. Participation in ECL activities or holding a job could also result in delaying homework completion until the late evening, further delaying bedtimes.

More importantly, the academic stress faced by Taiwanese high school students could also result in insufficient sleep. In today's competitive academic

environment, adolescents often feel compelled to prioritize academic success above all else. This pressure manifests in the form of heavy workloads, demanding schedules, and the pursuit of extracurricular activities aimed at enhancing college applications and prospects. As a result, Hua Wang and Xiaoyan Fan conclude academic stress has a positive direct effect on adolescents' sleep quality, suggesting that adolescents with higher levels of academic stress tend to have poor sleep quality. The results show that the impacts of academic stress on adolescents' sleep quality are contemplated by anxiety and school stress.

## B. Biological Factors

During puberty, there are major changes in one's circadian rhythm, where the timing of melatonin release has been shown to change. Increases in daytime drowsiness, the development of more adult-like REM sleep patterns, and a change in the circadian rhythm toward an owl-like propensity for later bed and wake-up times. The melatonin production of the adolescent body doesn't start until approximately 11 pm, peaks at 7 am, and then declines at 8 am. Adult melatonin levels, on the other hand, peak at 4 am. For this reason, waking up an adult at 4 am is the same as waking up an adolescent at 7 am.

School schedules affect adolescent sleep patterns by imposing earlier rise times that are asynchronous with the circadian rhythm. In other words, teenagers must wake up at a time when their bodies desire to be asleep and remain awake and engaged. Teenagers are unable to change their bedtime in accordance with their knowledge of having to wake up early since they naturally become more attentive during the night. Physically, they won't become sleepy until melatonin production begins later in the night. Students can't push themselves to go to bed early enough to receive a full night's sleep because the circadian system isn't able to readily adapt to changes in the sleep-wake cycle.

## III. Research Analysis

### A. Interview with a Professor Specializing in Sleep Research at National Taiwan University

To explore conventional world sleep issues, we engaged in an interview with Dr. Fang-Chia Chang. Dr. Chang, currently a professor in the Department of Veterinary Medicine at National Taiwan University and a board member of the Taiwan Sleep Medicine Association, earned his Ph.D. in Anatomy and Neuroscience from the University of Texas. His research centers on sleep physiology, making him one of the rare experts in Taiwan dedicated to fundamental sleep studies.

We start by investigating what kinds of signs could be an indication of insufficient sleep:

We: How to verify whether you are getting enough sleep every day? (如何驗證自己每天的睡眠時間夠不夠?)

Dr. Fang-Chia Chang: You will feel tired when you get up, and that means it is not enough. You will be tired when you get up. After you get up, you will not feel awake and feel that today is another good day, but you are just tired. That just wasn't enough. (起來會累，起來以後你沒有那種清醒感，覺得今天又是美好的一天，就是累。那個就是不夠。)

Then, we delve into the negative impacts of insufficient sleep:

We: We have also seen that long-term short-term sleep, or sleep that is often disturbed, can cause many diseases. Are these related? (我也看到說長期的短期睡眠，或是說常常被打擾的睡眠，它會造成許多的疾病。這些是有什麼關係嗎?)

Dr. Fang-Chia Chang: There are many, such as insomnia caused by some stress, which will affect some of your mental illnesses. For example, depression and anxiety are actually related to lack of sleep. There are some infectious diseases, your resistance and immunity will be reduced. This has been reported in the literature. So this part will increase your susceptibility to colds or COVID-19, etc. These are all directly related. Even more serious, in the long term, there may be some neurological diseases, which will also have some impact, especially if you have some neurological diseases yourself. Lack of sleep will aggravate neurological diseases such as epilepsy, which will worsen due to lack of sleep. Yes, it will worsen epilepsy, so this part is relevant. There is definitely a certain correlation, so this part may have to be considered. Therefore, lack of sleep will indeed cause some subsequent antibiotics and some consequences. (有很多啊，像是有一些壓力所造成的失眠症。這部分會影響到你的一些精神性的疾病。比方說憂鬱症、焦慮症，這些事實上跟睡眠不足是有關係的。有一些的感染症，你的抵抗力會下降，免疫力會下降，這都有文獻報告。所以這部分會更增加你比較容易感冒。或者是比較容易感染COVID-19啊，這些都有直接的相關性。甚至於說比較嚴重，更嚴重的長期來講的話，可能有些神經性的疾病，也會有一些影響。特別是你本身就有一些神經性疾病的睡眠在不足，那會加重它的惡化這種神經性疾病。舉個例子來講，像癲癇，就會惡化因為睡眠不足而惡化。所以這部分，可能必須考慮。所以睡眠不足的確會造成後續的一些抗生物質，一些後果。)

He also adds on that inadequate sleep could also cause sports injuries, stating:

Dr. Fang-Chia Chang: Because your concentration will be poor, your coordination will become worse, especially the body parts. This is certain, and they will all have different effects. (因為你注意力會不好，你的協調力會變差。尤其是身體的部分會變差。這是一定的，這都會有不同的影響的。)

Then, we asked potential solutions for inadequate sleep:

We: So if I had a very short sleep and a very lack of sleep the day before yesterday, how can I adjust this state today? (那如果我前天有非常短暫的睡眠，非常缺乏的睡眠。那到今天我要如何調整這個狀態呢?)

Dr. Fang-Chia Chang: If you have been in a short-term sleep for a long time, and you suddenly try to sleep for many hours a day, there is no way to make up for it. For example, is it helpful to catch up on sleep during the weekend or on the 6th? It helps a little bit. But it doesn't help much, because you have been in a state of long-term insomnia and lack of sleep for a week and five days, so I can't say it's useless, but the effect is limited. So the way to cure cauldron cramps is to get enough sleep every day. Basically, you need to get enough sleep every day. This is the most basic thing. (比方說weekend的時候補眠，六日的時候補眠，有沒有用?多少有一點幫助。但是幫助不大。因為你前面已經一個禮拜五天的時間，其實就是處於長期失眠，睡眠不足的狀態。所以，不能說沒用。但是效果有限。所以，釜底抽薪的辦法還是要每天睡眠要充足。就是要基礎上每天睡眠都要充足，這是最基本的。)

We also asked about how long an adolescent should sleep:

We: So let's put it this way, we are about 16 or 15 years old. How much sleep should we get every day? What time do we go to bed and what time do we get up?(那照這麼說我們，就大概十六十幾歲，十五歲的青少年。每天應該會有多少睡眠才算，就是幾點睡覺，幾點起來?)

Dr. Fang-Chia Chang: Let me give you a reference, it takes about 8.2 hours between 19 and 30 years old. People aged 19 to 30 have an average of 8.2 hours. Then at your age, the average is about 8.5 hours. It is true that some people sleep longer and some people sleep shorter. But this is an average. It does not necessarily mean that a person must sleep for 8.5 hours.(我給你一個參考資料，19到30歲大概要8.2個小時。19到30歲，平均8.2個小時，那你們這個年紀大概8.5個小時，平均。那的確有些人會睡得比較長，有些人睡得比較短。但是這個是平均值。不一定說明一個人一定要睡滿8.5個小時才夠。)

We: So why is there such a big difference between when we sleep 7.5 hours and when we sleep 8.5 hours?(那為

什麼我們會睡7.5小時跟8.5個小時，為什麼這一個小時會差那麼多呢?)

Dr. Fang-Chia Chang: Your body's repair is not enough. Another thing is the recovery status of your nerves. This will all have an impact. In fact, there is a natural circadian rhythm in our body, which is our day and night rhythm cycle. The circadian rhythm cycle cannot move, so if your sleep is short, it is actually very bad. The fact is that you just can't sleep that long, but that doesn't mean you shouldn't sleep that long. So there will definitely be problems in the long run.(你的身體的修復還不夠啊。還有的就是你的神經的恢復的狀況。這都是會有影響的。那我們身體裡面事實上有一個自然的circadian rhythm律程，就是我們日夜節律週期。日夜節律週期是不能動的，那你的睡眠的短的話，事實上是很against。那事實上你只是沒辦法睡那麼久，但不是說你不應該睡那麼久。所以長期下來一定會有問題。)

Because most of the second half of our sleep is rapid eye movement sleep. The period of sleep during the rapid mobilization period is related to your nerve repair and the operation of your entire nerve network. And your learning and memory. So you can find a very simple phenomenon: for example, if you have a midterm exam, will you stay up late to study? You may have recited for three hours, but stayed up late and only slept for three or four hours. But most of these four hours are spent in deep sleep. Because our sleep cycle begins with deep sleep, followed by light sleep and rapid eye movement sleep. But you are gone from behind and have no ability to repair yourself. Therefore, the recovery of the neural network of repair ability, and your learning and memory will actually become worse. So you will find that, for example, after you stay up late, although you may seem to remember for a short time that you took the exam, you will forget it all after a week. Because your memory does not have it, your entire memory has not solidified it. If it is not solidified, it is not yours, and it will not be stored in the brain. (因為我們在睡眠的後半段的部分大部分是快速動眼期睡眠。快速動眼期睡眠這一塊時間是跟你的神經修復，跟你的神經的整個網絡的運作有關。還有你的學習記憶。所以你可以發現說一個很簡單的一個現象：比方說你要期中考，你是不是會熬夜念書?你可能念了三個小時，就是熬夜只睡了三個小時或四個小時。可是你這四個小時裡面大多數都在深度睡眠裡面。因為我們的睡眠週期剛開始都是會跑到深度睡眠，後面就是淺層睡眠跟快速動眼期睡眠。可是你後面都不見了，沒有自我修復的能力。所以修復能力神經的網路的恢復，還有你的學習記憶事實上就會變差。所以你會發覺說比方說你熬夜了以後，你雖然好像短期記得起來你去考了試，一個禮拜後全忘光。因為你的記憶力沒有，你的整個記憶沒有把它固化起來，沒有固化起來就不是你的東西，就沒有存在大腦裡面。)

During the discussion with Dr. Fang-Chia Chang, he elucidated the diverse ramifications of inadequate sleep, emphasizing the crucial need for sufficient rest:

**Signs of Insufficient Sleep:** Dr. Fang-Chia Chang explains that feeling tired upon waking up indicates insufficient sleep, emphasizing the importance of feeling refreshed and awake in the morning.

**Negative Impacts of Insufficient Sleep:** Long-term lack of sleep or sleep disturbances can lead to various health issues, including mental illnesses like depression and anxiety, reduced immunity, increased susceptibility to infections like colds or COVID-19, and even neurological diseases such as epilepsy.

**Injuries and Performance:** Inadequate sleep can impair concentration, coordination, and overall performance, increasing the risk of sports injuries and affecting daily activities.

On the other hand, Dr. Fang-Chia Chang also highlights solution for both adolescents and adults:

While catching up on missed sleep during weekends or holidays may help to some extent, the most effective solution is to ensure sufficient sleep every day. Consistency in sleep patterns is crucial for overall well-being.

**Recommended Sleep Duration:** The ideal duration of sleep varies with age, with adolescents needing around 8.5 hours of sleep on average. However, individual variations exist, and it's essential to prioritize quality sleep over a specific duration.

## B. Analysis on scholarly studies that provide insights for policy change

### 1. Background

Understanding the importance of sleep, we delve into the issue and research for tangible policy changes. Also, to demonstrate the academic benefits sleep could bring and referencing potential public policy for school schedules, we sourced a study by Scott E. Carrell and his colleagues from data based the United States Air Force Academy (USFA), a fully accredited post-secondary institution with an annual enrollment of around 4,500 students. USFA offers a diverse array of majors across disciplines such as humanities, social sciences, basic sciences, and engineering. Students are required to graduate within four years and typically serve at least a five-year commitment as commissioned officers in the United States Air Force upon graduation. Despite its military context, USFA shares similarities with other selective

colleges and universities in the United States, boasting faculty with graduate degrees from reputable programs and small class sizes facilitating interaction between students and faculty.

## 2. Methods

To investigate the impact of early school start times on academic performance, the researchers employed a mathematical equation. Initially, they examined whether students enrolled in morning classes achieved different grades compared to their peers. This analysis factored in individual student characteristics such as SAT scores, gender, and athletic background to ensure fair comparisons. Additionally, the researchers accounted for the influence of other students in the class on grades. Subsequently, they analyzed how changes in class start times affect academic performance. The findings suggested that earlier start times were associated with slightly lower grades, although the effect varied depending on the specific start time.

## 3. Results

The results of the study reveal several key findings regarding the impact of school start times on academic achievement. Graphical analysis (Figure 2) indicates that students randomly assigned to a first-period class tend to have lower normalized grades compared to those without a first-period class on the same scheduled day. Additionally, the distribution of grades for students with a first-period class shifts towards higher grades as the start time of the first-period class gets later.

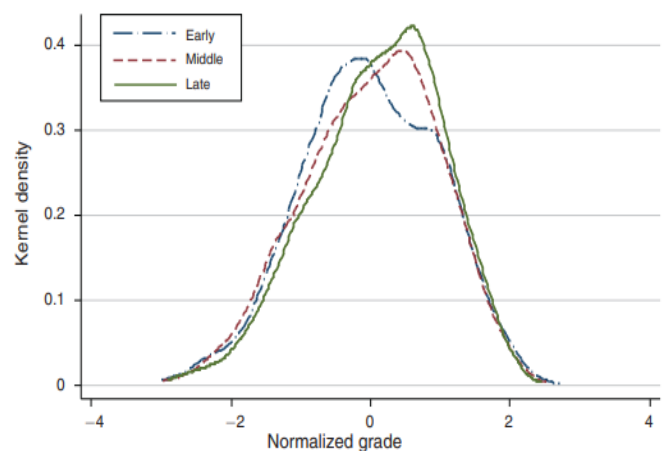


Figure 2. Distribution of Normalized Grades for All Courses by First Period Enrollment (Carrell, 2011)

The data depicted in these figures indicate that as the first period commences later, there is an upward trend in the distribution of student grades.

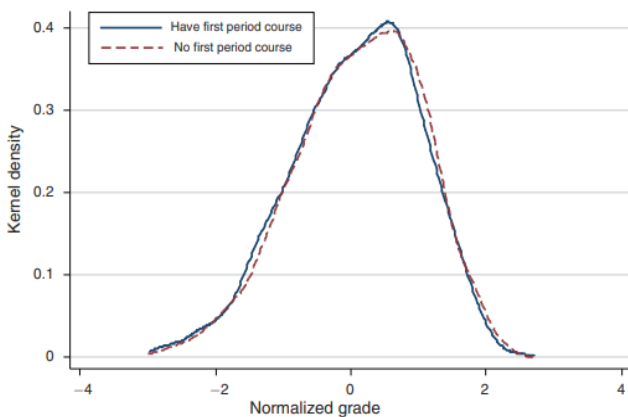


Figure 3. Grade distribution of students enrolled in a first-period class across various start-time cohorts (Carrell, 2011)

The study concludes that early school start times have a negative impact on student academic achievement. They found that students assigned to first period classes tended to earn lower grades overall compared to those with later classes on the same day. This effect was not solely due to poor performance in the first period but extended to subsequent classes on the same day. Importantly, the findings suggest that delaying school start times by 50 minutes, as observed in the sample, could significantly improve student outcomes, with the benefits akin to raising teacher quality by roughly one standard deviation. Therefore, the study underscores the potential cost-effective benefits of later start times in improving student achievement and calls for consideration of this policy change by education administrators.

## 5. Conclusion and Suggestions

The comprehensive analysis conducted on adolescent sleep habits and their implications reveals a troubling narrative of inadequate sleep globally, particularly among Taiwanese students. The negative impacts of insufficient sleep range from mental health issues to impaired cognitive function, increased susceptibility to infections, and heightened risk of neurological diseases. More importantly, insufficient sleep resulted in lower academic performance. To solve this, we urge the government to make changes to school schedules. Studies have suggested that delaying school start times could significantly improve academic performance and overall well-being among students. Therefore, tangible policy changes are needed at multiple

levels to address the epidemic of insufficient sleep among adolescents through three key aspects:

Implementing later school start times can significantly improve academic performance and overall well-being among students. Education administrators should consider delaying the start of the school day by at least 50 minutes to allow students to get sufficient sleep and align with their natural circadian rhythms.

Schools should prioritize student well-being over academic rigor by implementing policies that reduce academic stress. This could include limiting the number of extracurricular activities or homework assignments, providing adequate support for students struggling with workload, and promoting a culture of work-life balance.

Educate students, parents, and teachers about the importance of sufficient sleep for academic success and overall health. Raise awareness about the negative impacts of inadequate sleep and encourage stakeholders to prioritize sleep hygiene.

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