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ORIGINAL RESEARCH

The Impact of Delayed School Start Times During COVID-19 on Academic Performance: A Longitudinal Naturalistic Study in Italian High Schools

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Background: Delaying school start times has been proposed as a potential solution to address chronic sleep curtailment among adolescents and its negative consequences on their physical and mental well-being. This study investigates the impact of delayed school start times due to the COVID-19 pandemic on academic achievement.

Subjects and Methods: Two separate observational studies were conducted involving high school students from the first/second year (n=232) (Study 1) and from the final year (n=39) (Study 2). Multivariate Analyses of Covariance were performed to assess for statistical differences in academic performance (ie, global, humanistic, and scientific performance) and absenteeism (ie, number of school absences). Two main factors were considered: "school start time" (ie, standard-8:00 AM vs late-9:40 AM) and "time interval" (ie, first academic semester vs second academic semester), controlling for the school year (Study 1) and circadian preference (Study 2).

Results: Delaying school start times was positively associated with better academic performance in scientific subjects among first/second-year students ($F_{1,229}$=6.083, p=0.026) and global academic performance among last-year students ($F_{1,35}$=4.522, p=0.041). Furthermore, first/second-year students significantly increased their school achievement ($F_{1,229}$>29.423, p<0.001) and school absences ($F_{1,229}$=66.160, p<0.001) during the second semester of the academic year. No significant effect of "school start time" on school attendance was observed. Additionally, circadian preference was found to be a significant covariate among last-year students, with early chronotypes exhibiting better academic performance (r>0.369, p<0.025).

Conclusion: These findings confirm past evidence about the beneficial effects of delayed school start times on academic outcomes, with the additional advantage of observing them within a natural context that emerged during the pandemic. Further research is needed to explore the phenomenon more systematically and take into account the broader implications of implementing this change.

Keywords: later school start time, academic achievement, adolescents, COVID-19 pandemic, circadian preference

Introduction

Teenagers' recommended amount of sleep is usually 8 −10 hr a night.[1] However, several studies have shown that chronic sleep curtailment affects this age group.[2] The resulting negative effects on this populations' physical and mental well-being, cognitive performance, and risk behaviors are well-documented.[3]

Several aspects contribute to determining chronic sleep loss among adolescents. Developmental changes in homeostatic[4,5] and circadian[6] sleep regulation promote the tendency to be more active in the evening and wake up later in young people.

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Furthermore, there are environmental and social factors, such as using electronic devices in the evening[7] and early awakening due to the early school start times.

Several studies worldwide have investigated the impact of delaying school start times on young people's academic performance and mental health.[8,9]

Recent systematic reviews and meta-analyses have consistently shown positive associations between later start times and improved well-being (ie, reduced depression, anxiety, and stress symptoms).[10,11] In addition, students who started school later showed increased motivation, more attention, better grades, and decreased rates of absenteeism and tardiness.[12,13]

A recent study by Alfonsi et al in Italy[14] showed that a one-hour delay in starting school was associated with longer total sleep duration, greater attentional performance, better attendance, and academic outcomes among high school students.

In the last few years, the restrictive measures implemented in the school environment to prevent the spread of the COVID-19 virus have enabled a natural experiment. Indeed, the health crisis caused by the COVID-19 pandemic presented a huge challenge to school systems worldwide,[15] initially resulting in the suspension of in-person classes and then in their gradual resumption based on the preventive measures adopted by each country (eg, hand washing, use of face masks, adequate ventilation, etc.).[16] Several schools have implemented staggered school start and end times or school on alternative days to ensure social distancing and prevent overcrowding at school arrivals and departures.[17]

In Italy, schools reopened in September 2020 after being closed nationwide for 6 months due to the coronavirus outbreak. Ministerial guidelines included staggered entry times for students for the school year 2020/2021.[18]

The present study aimed to longitudinally observe the impact of later school start times on academic achievement in the era of COVID-19, by comparing high school classes with different school start times (ie, standard vs delayed school start time) and considering two different time periods (ie, first and second school semesters).

For this purpose, we initially implemented the study protocol with a sample of high school students enrolled in the first and second years of the 5-year high school program in Italy (Study 1). Then – given the persistence of the same ministerial measures during the following year – we had the opportunity to extend the research to include the last-year classes as well (Study 2). In this subsequent study (Study 2), we collected circadian preference measures using dedicated questionnaires.

By delaying school start times, young people are more likely to get the recommended amount of sleep that optimizes their cognitive abilities and academic performance. Therefore, we expect that the beneficial effect of the delayed school start times on academic performance and school attendance would be confirmed even in the unprecedented scenario proposed by the pandemic. Furthermore, in line with previous evidence, we hypothesized that circadian preference may play a role in mediating the observed effects.

Materials and Methods

Study Design and Participants

Initially, we identified some schools in the Lazio region that staggered entry time to aid the restart of in-person lessons after the lockdown during the 2020/2021 school year. Among the institutes adhering to the initiative, we exclusively selected the high school institutes that (1) had kept the entry times (ie, standard or delayed) unchanged for the entire school period, (2) had scheduled different entry times for classes of the same year. Finally, we selected the "Isacco Newton" Institute (Rome), where 10 classes (6 first-year classes and 4 second-year classes) were suitable for recruitment (Study 1).

The study was replicated in the following school year (2021/2022) on 2 fifth-year classes belonging to the "Via Copernico" Institute (Pomezia) (Study 2).

A total of 232 students from the first 2 years of the "Isacco Newton" Institute (146 males; mean age=15.34±0.039 years) were selected for Study 1. Of these, 107 students (46.1%) belonged to the group with standard school start time (8.00 AM: Standard Start Time) and 125 (53.9%) to the group with delayed school start time (9.40 AM: Delayed Start Time) (Table 1).

Table 1 Sociodemographic Characteristics of the Sample

	School Year 2020–2021 (N=232)		School Year 2021–2022 (N=39)	
	Mean	**SE**	**Mean**	**SE**
Age	15.34	0.039	18.08	0.057
	N°	**%**	**N°**	**%**
Gender				
Male	146	62.9	23	59.0
Female	86	37.1	16	41.0
School Start Time				
8:00 AM	107	46.1	20	51.3
9:40 AM	125	53.9	19	48.7
School year				
First Year	147	63.4	N/A	N/A
Second Year	85	36.6	N/A	N/A
Last Year	N/A	N/A	39	100.0
Circadian Typology				
Evening-Type	N/A	N/A	6	15.4
Intermediate-Type	N/A	N/A	26	66.7
Morning-Type	N/A	N/A	6	15.4
Learning Disabilities				
Yes	7	3.0	6	15.4
No	225	97.0	33	84.6

Abbreviation: N/A, not available.

Overall, 39 students (23 males; mean age=18.08±0,057 years) from the last year of "Via Copernico" Institute were recruited for Study 2. Regarding the school start time, these two groups were equally distributed: 51.3% (n=20) of the students belonged to the 'Standard Start Time group', and 48.7% (n=19) to the 'Delayed Start Time' group (Table 1).

Overall, 3% of the participants from Study 1 and 15.4% of the participants from Study 2 were affected by intellectual disabilities, and their distribution did not differ between the two types of entry times (Study 1: $\chi 2=0.353$; p=0.552; Study 2: $\chi 2=0.672$; p=0.412, respectively) (Table 1).

In Study 2, we administered a standardized questionnaire to collect circadian preferences at the beginning of the school year. The online version of the questionnaire was created using the Google Form platform, and we provided each student with a specific link for completion. Participants (or parents in the case of minors) filled out the online questionnaire after reading the informed consent form, providing their explicit agreement to participate.

The name of each student was replaced with an identifying alphanumeric code to guarantee privacy.

The research was conducted following the Declaration of Helsinki and was approved by the Institutional Review Board of the Department of Psychology - University of Rome "Sapienza" (Prot. n. 0002617, 07/12/2021).

Measures

Measures of Academic Performance and School Attendance

According to the academic grading system used in Italy, we considered academic achievement at two different moments of the school year: at the end of the first half of the academic year (T1: referring to the period from September to January) and at the end of the second half of the academic year (T2: referring to the period from February to June).

In Italian secondary schools, a 10-point scale is used (ie, 10 is the highest, and pass starts at 6).

Specifically, we considered academic performance in science and humanities fields of studies common to all classes (ie, math/physics and Italian/English language) and global academic performance (ie, the average of marks across all subjects).

As an indicator of school attendance, we also considered the total number of school absences for each student in the first and second halves. of the academic year (T1, T2).

Circadian Preference

The Italian version of the Morningness–Eveningness Questionnaire for Children and Adolescents (MEQ-CA)[19] was administered to identify the circadian preference of our participants. MEQ-CA is a 19-item test that also allows subdividing participants into five categories: definitely morning-type (70–86), moderately morning-type (59–69), intermediate-type (42–58), moderately evening-type (31–41), and definitely evening-type (16–30).

Statistical Analyses

A similar statistical analysis was planned for the two different studies. A Mixed Multivariate Analysis of Covariance (MANCOVA) was conducted – for the first- and second-year classes (2020/2021 school year) and for the last-year classes (2021/2022 school year) - to observe the effect of delaying school start times on academic performance and school attendance in both semesters. We considered as main factors "school start time" (Standard vs Delayed) and "time interval" (T1 vs T2), between- and within-subjects factors, respectively. School year (first- and second-year classes) and circadian preference (total score on the MEQ-CA questionnaire) were considered as covariates for the first/second- and last-year classes, respectively.

For each time interval, all measures of academic performance (global academic performance, scientific academic performance, and humanistic academic performance) and the number of school absences were considered dependent variables.

The normal distribution of the original data was checked, and skewed data were transformed into normal distribution in case of violation of this assumption (ie, logarithmic transformation for the number of absences).

All data were analyzed using Statistical Package for Social Science (SPSS; version 25.0; IBM SPSS, Armonk, NY) and Matlab R2019. Values of $P \leq 0.05$ were considered to be statistically significant.

Results

Study 1: Effects of Delayed School Start Time for Students in the First and Second Year of High School (School Year 2020–2021)

Results of the two-way mixed MANCOVA ("School start time" vs "Time interval"; covariate: "School year") on academic performance (Global academic performance, Scientific academic performance, Humanistic academic performance) and school attendance showed statistically significant differences between the two groups (Wilks' Lambda = 0.921, $F_{4,226} = 4.838$, $p = 0.001$) and the two time points (Wilks' Lambda = 0.553, $F_{4,226} = 45.673$, $p < 0.001$) and no interaction effect between these two main effects (Wilks' Lambda = 0.980, $F_{4,226} = 1.180$, $p = 0.320$), after controlling for the covariate "School year" (Wilks' Lambda = 0.947, $F_{4,226} = 3.141$, $p = 0.015$).

Specifically, subsequent ANCOVAs on each dependent variable (Table 2 and Figure 1) reveal that – independently from the time interval – students with delayed school start times showed better scientific academic performance. In addition, both groups reported higher number of absences and higher school grades (ie, better academic performance) on all examined fields of studies during the second time interval (ie, at the end of the second half of the academic year) than the first.

Table 2 Univariate Test of the Two-Way Mixed MANCOVA with "School Year" as Covariate and "School Start Time" and "Time Interval" as Between and Within Factors, Respectively (N=232)

	School Start Time			Time Interval			School Start Time* Time Interval			Covariate (School Year)		
	$F_{1,229}$	*p*	η_p^2	$F_{1,229}$	*p*	η_p^2	$F_{1,229}$	*p*	η_p^2	$F_{1,229}$	*p*	η_p^2
Global academic performance	1.805	0.180	0.008	93.630	<0.001**	0.290	1.996	0.159	0.009	1.439	0.232	0.006
Scientific academic performance	6.083	0.014*	0.026	29.423	<0.001**	0.114	2.088	0.150	0.009	1.089	0.298	0.005
Humanistic academic performance	1.385	0.240	0.006	45.084	<0.001**	0.164	1.201	0.274	0.005	0.324	0.570	0.001
School absences	2.285	0.132	0.010	66.160	<0.001**	0.224	0.017	0.113	0.011	7.757	0.006*	0.033

Note: Asterisk indicates statistical significance (*p≤0.05; **p<0.001).

The covariate "School years" revealed a positive correlation with the number of absences (r_{pb}=0.186, p=0.005), pointing to a higher number of absences in the second-year classes compared to the first-year classes (first-year classes [Mean±SE]: 1.20±0.03 vs second-year classes [Mean±SE]: 1.36±0.04; t=−2.869; p=0.005). Absolute performance values are reported in Supplementary Table 1.

Study 2: Effects of Delayed School Start Time for Students in the Last Year of High School (School Year 2021–2022)

Concerning the circadian typology, 15.4% of students were "evening-type", 15.4% were "morning-type", and the majority (66.7%) were classified as "intermediate-type".

Results of the two-way mixed MANCOVA ("School start time" vs "Time interval"; covariate: "Circadian preference") on academic performance (Global academic performance, Scientific academic performance, Humanistic academic performance) showed no effect of the time interval (Wilks' Lambda = 0.887, $F_{3,33}$ = 1.405, p = 0.259), and statistically significant differences between the two groups (Wilks' Lambda = 0.463, $F_{3,33}$ = 12.748, p < 0.001) and significant interaction between the two main factors (Wilks' Lambda = 0.713, $F_{3,33}$ = 4.437, p = 0.010), after controlling for the covariate "Circadian preference" (Wilks' Lambda = 0.782, $F_{3,33}$= 3.061, p = 0.042).

Subsequent ANCOVAs on each dependent variable (Table 3 and Figure 2) reveal that – independently from the time interval – students with delayed school start times showed better global academic performance. In addition, the results of the univariate ANCOVAs showed a significant interaction between the time interval and the school start time regarding overall and humanistic performance. Specifically, the two classes did not show significant differences in global performance during the first semester ($F_{1,35}$ = 2.387; p = 0.131), whereas in the second semester, the delayed class showed higher scores ($F_{1,35}$ = 6.830; p = 0.013) (Figure 2). Concerning humanistic performance, the standard class showed a slight decrease – although not significant – between the two time intervals, unlike the improvement trend shown by the delayed class.

From the univariate ANCOVAs, we can also observe that the covariate "circadian preference" had a significant effect on each dependent variable. Specifically, a positive correlation was observed between the total score on the MEQ-CA (high scores indicate morning preference) and global academic performance (r=0.503; p=0.001), scientific academic performance (r=0.412; p=0.010), and in humanistic academic performance (r=0.369; p=0.025). Absolute performance values are reported in Supplementary Table 2.

Discussion

This study represents the outcome of a natural experiment resulting from the preventive measures introduced by the Italian government to contain the spread of COVID-19. In Italy, some schools implemented staggered entry times to reduce the

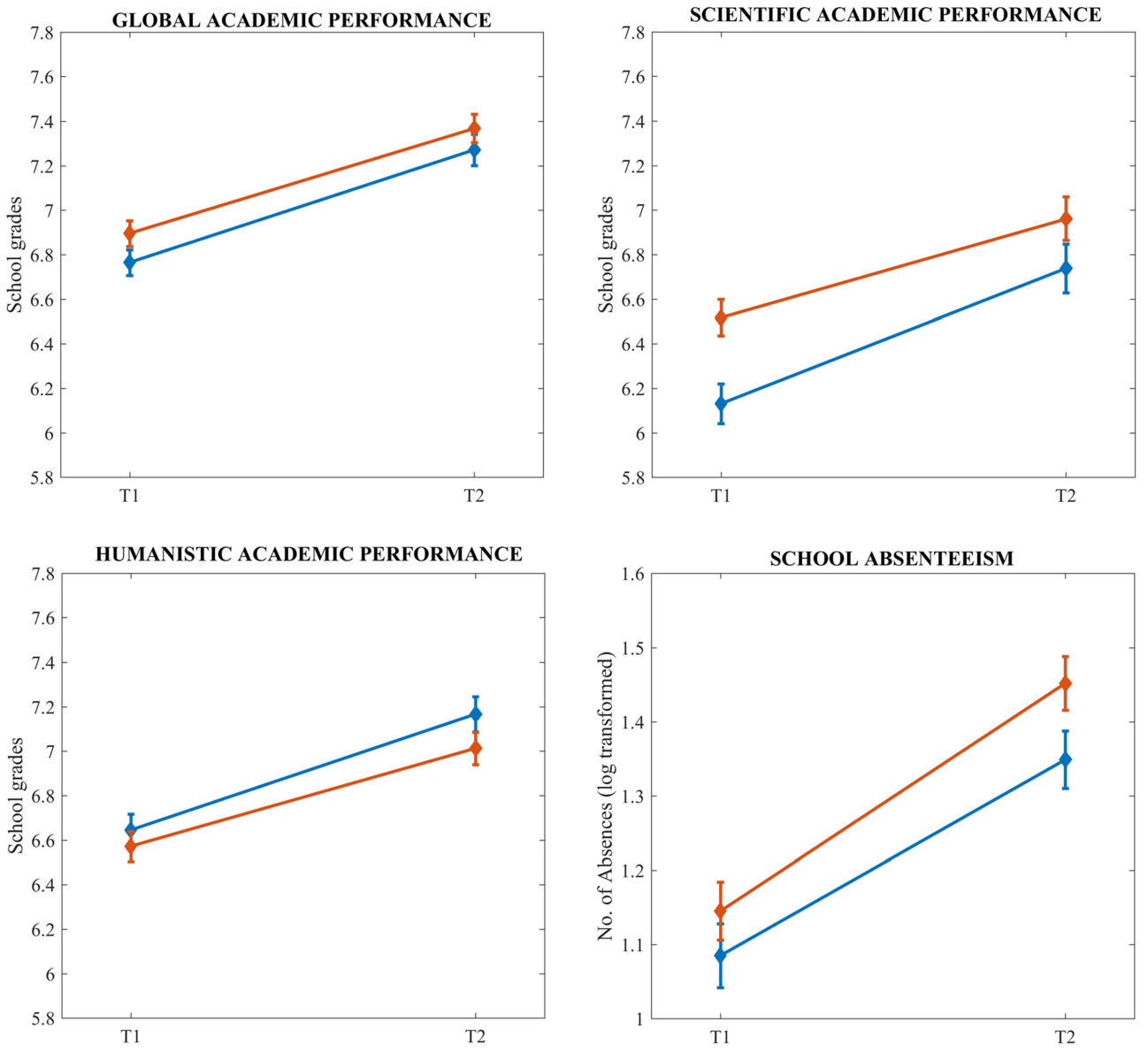

Figure 1 Mean (and SE) across the two time periods (T1: first semester; T2: second semester) in the two types of classes (Delayed school start time – Orange line; Standard school start time – Blue line) of the first/second-year of high school.

possibility of contagion,[18] providing a unique opportunity to examine the outcomes of different school start times among high school students.

The effects of late school entry time were initially investigated during the 2020/2021 academic year in first- and second-year upper school classes. Results showed (a) overall improvement in academic achievement over the year, regardless of school start time, and (b) better academic performance in scientific subjects for students with late school starts than students with standard entry times.

In the following school year (ie, 2021/2022), final-year high school students were recruited, and a specific circadian preference questionnaire was administered. Even in this case, the later school start class showed better academic performance than the standard class. However, this time, no significant performance increase was observed throughout the academic year.

In Italy, the academic year begins in the first half of September. It is traditionally divided into two semesters: from September to January (ie, the first school semester) and from February to June (ie, the second school semester). Since these two periods are consecutive, the time effect observed in the first- and second-year classes probably represents the

Table 3 Univariate Test of the Two-Way Mixed MANCOVA with "Circadian Preference" as Covariate and "School Start Time" and "Time Interval" as Between and Within Factors, Respectively (N=38)

	School Start Time			Time Interval			School Start Time * Time Interval			Covariate (Circadian Preference)		
	$F_{1,35}$	p	η_p^2	$F_{1,35}$	p	η_p^2	$F_{1,35}$	p	η_p^2	$F_{1,35}$	p	η_p^2
Global academic performance	4.522	0.041*	0.114	0.397	0.533	0.011	12.237	0.001*	0.259	9.674	0.004*	0.217
Scientific academic performance	0.043	0.837	0.001	2.709	0.109	0.072	2.847	0.100	0.075	7.055	0.012*	0.168
Humanistic academic performance	0.976	0.330	0.027	0.512	0.479	0.014	8.249	0.007*	0.191	6.229	0.017*	0.151

Note: Asterisk indicates statistical significance (p≤0.05).

direct consequence of the learning effect and the natural improvement of performance at the end of the academic year, regardless of the starting time. Conversely, the absence of a time effect in final-year classes could be related to the small sample size of this group and the resulting underpowered analyses.

From a descriptive point of view, it is interesting to observe that older students (fifth-year classes) show an overall higher performance compared to first- and second-year classes. This evidence could be associated with the fact that they have a consolidated academic history and consequently receive a more robust assessment from teachers. These factors might also contribute to explaining the absence of variations between the two school semesters, unlike what is observed in first/second-year classes in Study 1.

Regarding the effect of school start time, the results of both study protocols (first/second year and fifth year) are consistent with many studies describing the beneficial effects of delaying school start time.[10] Sleep loss impairs sustained attention, executive functions and memory, hindering learning ability and overall academic performance.[20] Notably, chronic sleep deprivation significantly affects cognitive performance and academic achievement.[3,21] In this study, we did not have the opportunity to collect any information about the student's sleep-wake patterns before and during the observation period using instruments such as questionnaires or weekly sleep diaries. However, based on the existing literature,[22,23] we can hypothesize that the possible sleep gain due to the delay of the rising time may have facilitated learning, leading to better academic performance. In fact, a very recent Norwegian study[24] reported that even a very short delay in starting school (ie, 15 min) was associated with increased sleep (ie, 7.2 min).

The selectively observed improvement in academic performance in scientific subjects could be attributed to the fact that the school of affiliation for the first- and second-year classes is a scientific high school. Therefore, the performance in specialized subjects such as mathematics and physics could most indicate students' actual performance. Furthermore, some evidence shows that academic subjects based on fluid cognition (ie, mathematics or physics) are more sensitive to time-of-day task variation than subjects involving crystallized intelligence.[25,26]

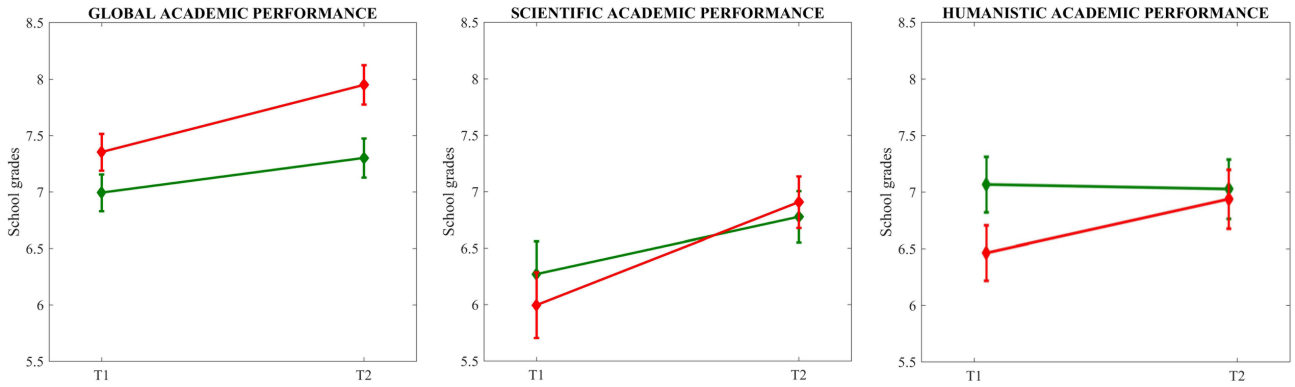

Figure 2 Mean (and SE) across the two time periods (T1: first semester; T2: second semester) in the two types of classes (Delayed school start time – Red line; Standard school start time – Green line) of the last year of high school.

Despite the small variations in absolute performance values, the size of the observed changes corresponds to large or medium effects, as reflected by the partial eta squared values that indicate a relatively high proportion of variance explained by these factors.

Surprisingly, no significant differences in absenteeism were found between the two groups. Among the benefits of delaying school start times, several studies found a reduction in early leaving, tardiness, and absenteeism.[27,28] However, other studies found no change in school attendance after introducing late start times.[29,30]

The significant effect of the covariate "Circadian preference" on all academic performance categories (global, humanistic, scientific) confirms the positive relationship between early chronotype and better school performance.[26] It can be assumed that delaying current school and university timings can create more favorable learning conditions for evening types, who naturally tend to perform better in the afternoon hours.[31] In this way, later school start times could greatly reduce the existing gap in academic performance between the two circadian chronotypes.

Current findings on the effects of late school start times are still inconsistent and heterogeneous. This is probably due to multiple confounding variables (eg, circadian typology, age, sleep habits, social cues, etc.) and the different experimental settings in which the postponed start time was implemented. A recent review by Ferrante and Leone[32] described how different solar clocks (ie, the distance between school start time and sunrise) can strongly influence the effects of delayed school start times.

The implementation of preventive measures related to the spread of COVID-19 made it possible to study this phenomenon in a natural setting. However, the pandemic involved other aspects that could affect the obtained results. For example, the students' sleep-wake rhythms and learning ability in this study may have been affected by immediate class interruptions in the initial phases of the national lockdown and the use of remote learning long before school reopening. Therefore, these aspects make it difficult to generalize these findings to other contexts and periods.

In addition, the results of this study confirm the beneficial effect of the later school start time observed in our pilot study.[14] Furthermore, investigating this phenomenon in a natural context eliminates a whole range of confounding variables associated with being subject to experimentation (ie, self-selection bias).

Delaying school start time undoubtedly represents a valid solution to alleviate sleep loss among adolescents, as also confirmed by the absence of a subsequent delay in sleep onset time.[14] However, we should also consider other potential and effective countermeasures. Indeed, the lack of sufficient amount of sleep in this population is also linked to environmental factors such as a greater probability of involvement in social, school, and sporting activities in the evening hours,[33] reduced parental control,[34] or the tendency to use electronic devices close to bedtime.[35] Therefore, a possible solution should also involve increasing awareness among young people about proper sleep habits. In this regard, some studies have reported the effectiveness of school-based sleep education programs in disseminating sleep hygiene practices among adolescents.[36] Future studies should use devices such as wrist actigraphy to objectively detect sleep-wake rhythms, as well as consider subjective questionnaires and sleep diaries to ascertain the relationship between improved academic performance and sleep gain.

Given the wide-ranging consequences of chronic sleep curtailment on youth health and performance, it is essential to address this issue. By aligning school schedules with the natural sleep patterns of adolescents, we can help promote optimal cognitive functioning, improve academic outcomes, and promote overall well-being during this crucial developmental stage.

Achieving this change will undoubtedly require collaboration between schools, parents, and policymakers to address logistical issues and ensure appropriate support systems. However, considering relevant aspects such as the circadian typology and the quality of students' sleep could help establish a valuable criterion for implementing this solution, especially for those groups of students most affected by social constraints.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the

article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

Professor Luigi De Gennaro reports personal fees from Idorsia, outside the submitted work. The authors report no other conflicts of interest in this work.

References

1. Short MA, Weber N, Reynolds C, Coussens S, Carskadon MA. Estimating adolescent sleep need using dose-response modeling. *Sleep*. 2018;41(4): zsy011. doi:10.1093/sleep/zsy011
2. Owens JA, Weiss MR. Insufficient sleep in adolescents: causes and consequences. *Minerva Pediatr*. 2017;69(4):326–336. doi:10.23736/S0026-4946.17.04914-3
3. Alfonsi V, Scarpelli S, D'Atri A, Stella G, De Gennaro L. Later school start time: the impact of sleep on academic performance and health in the adolescent population. *Int J Environ Res Public Health*. 2020;17(7):2574. doi:10.3390/ijerph17072574
4. Jenni OG, Achermann P, Carskadon MA. Homeostatic sleep regulation in adolescents. *Sleep*. 2005;28(11):1446–1454. doi:10.1093/sleep/28.11.1446
5. Reynolds CM, Short MA, Kahn M, et al. Development of evening sleep homeostatic pressure in early adolescent boys. *Sleep Med*. 2023;110:54–59. doi:10.1016/j.sleep.2023.07.019
6. Crowley SJ, Van Reen E, LeBourgeois MK, et al. A longitudinal assessment of sleep timing, circadian phase, and phase angle of entrainment across human adolescence. *PLoS One*. 2014;9(11):e112199. doi:10.1371/journal.pone.0112199
7. Bartel K, Gradisar M. New directions in the link between technology use and sleep in young people. *Sleep Disord Child*. 2017;69–80. doi:10.1007/978-3-319-28640-2_4
8. Minges KE, Redeker NS. Delayed school start times and adolescent sleep: a systematic review of the experimental evidence. *Sleep Hypn*. 2016;28:86–95. doi:10.1016/j.smrv.2015.06.002
9. Biller AM, Meissner K, Winnebeck EC, Zerbini G. School start times and academic achievement-a systematic review on grades and test scores. *Sleep Hypn*. 2022;61:101582. doi:10.1016/j.smrv.2021.101582
10. Marx R, Tanner-Smith EE, Davison CM, et al. Later school start times for supporting the education, health, and well-being of high school students: a systematic review. *Campbell Syst Rev*. 2017;13(1):1–99. doi:10.4073/csr.2017.15
11. Yip T, Wang Y, Xie M, Ip PS, Fowle J, Buckhalt J. School start times, sleep, and youth outcomes: a meta-analysis. *Pediatrics*. 2022;149(6): e2021054068. doi:10.1542/peds.2021-054068
12. James SA, Erickson DJ, Lammert S, Widome R. School start time delays and high school educational outcomes: evidence from the START/LEARN study. *J Adolesc*. 2023;95(4):751–763. doi:10.1002/jad.12151
13. Tonetti L, Natale V, Randler C. Association between circadian preference and academic achievement: a systematic review and meta-analysis. *Chronobiol Int*. 2015;32(6):792–801. doi:10.3109/07420528.2015.1049271
14. Alfonsi V, Palmizio R, Rubino A, et al. The association between school start time and sleep duration, sustained attention, and academic performance. *Nat Sci Sleep*. 2020:1161–1172. doi:10.2147/NSS.S273875
15. Garg S, Aggarwal D, Upadhyay SK, Kumar G, Singh G. Effect of COVID-19 on school education system: challenges and opportunities to adopt online teaching and learning. *Humanit Soc Sci Rev*. 2020;8(6):10–17.
16. Sheikh A, Sheikh A, Sheikh Z, Dhami S. Reopening schools after the COVID-19 lockdown. *J Glob Health*. 2020;10(1). doi:10.7189/jogh.10.010376
17. Esposito S, Cotugno N, Principi N. Comprehensive and safe school strategy during COVID-19 pandemic. *Ital J Pediatr*. 2021;47:1–4. doi:10.1186/s13052-021-00960-6
18. Ministero Dell'Istruzione. Ministero dell'Università e della Ricerca. Adozione del Documento per la pianificazione delle attività scolastiche, educative e formative in tutte le Istituzioni del Sistema nazionale di Istruzione per l'anno scolastico, 2020/2021 [Ministry of University and Research. Adoption of the Document for planning school, educational and training activities in all institutions of the National Education System for the school year, 2020/2021]. Rome: Ministero dell'Is; 2020. Italian.
19. Tonetti L. Validity of the morningness-eveningness questionnaire for adolescents (MEQ-A). *Sleep Hypn*. 2007;9(2):47.
20. Astill RG, Van der Heijden KB, Van IJzendoorn MH, Van Someren EJW. Sleep, cognition, and behavioral problems in school-age children: a century of research meta-analyzed. *Psychol Bull*. 2012;138(6):1109. doi:10.1037/a0028204
21. Fonseca AG, Genzel L. Sleep and academic performance: considering amount, quality and timing. *Curr Opin Behav Sci*. 2020;33:65–71. doi:10.1016/j.cobeha.2019.12.008
22. Agostini A, Carskadon MA, Dorrian J, Coussens S, Short MA. An experimental study of adolescent sleep restriction during a simulated school week: changes in phase, sleep staging, performance and sleepiness. *J Sleep Res*. 2017;26(2):227–235. PMID: 27868260. doi:10.1111/jsr.12473
23. Short MA, Blunden S, Rigney G, et al. Cognition and objectively measured sleep duration in children: a systematic review and meta-analysis. *Sleep Heal*. 2018;4(3):292–300. doi:10.1016/j.sleh.2018.02.004
24. Evanger LN, Bjorvatn B, Pallesen S, Hysing M, Sivertsen B, Saxvig IW. Later school start time is associated with longer school day sleep duration and less social jetlag among Norwegian high school students: results from a large-scale, cross-sectional study. *J Sleep Res*. 2023;32:e13840. doi:10.1111/jsr.13840

25. Jankowski KS, Díaz-Morales JF, Vollmer C. Chronotype, time of day, and performance on intelligence tests in the school setting. *J Intell*. 2023;11 (1):13. doi:10.3390/jintelligence11010013
26. Zerbini G, van der Vinne V, Otto LKM, et al. Lower school performance in late chronotypes: underlying factors and mechanisms. *Sci Rep*. 2017;7 (1):4385. doi:10.1038/s41598-017-04076-y
27. Lenard M, Morrill MS, Westall J. High school start times and student achievement: looking beyond test scores. *Econ Edu Rev*. 2020;76:101975. doi:10.1016/j.econedurev.2020.101975
28. Dunster GP, de la Iglesia L, Ben-Hamo M, et al. Sleepmore in Seattle: later school start times are associated with more sleep and better performance in high school students. *Sci Adv*. 2018;4(12):eaau6200. doi:10.1126/sciadv.aau6200
29. Chan NY, Zhang J, Yu MWM, et al. Impact of a modest delay in school start time in Hong Kong school adolescents. *Sleep Med*. 2017;30:164–170. doi:10.1016/j.sleep.2016.09.018
30. Thacher PV, Onyper SV. Longitudinal outcomes of start time delay on sleep, behavior, and achievement in high school. *Sleep*. 2016;39(2):271–281. doi:10.5665/sleep.5426
31. Zerbini G, Merrow M. Time to learn: h ow chronotype impacts education. *PsyCh J*. 2017;6(4):263–276. doi:10.1002/pchj.178
32. Ferrante G, Leone MJ. Solar clock and school start time effects on adolescents' chronotype and sleep: a review of a gap in the literature. *J Sleep Res*. 2023;e13974. doi:10.1111/jsr.13974
33. Taillard J, Sagaspe P, Philip P, Bioulac S. Sleep timing, chronotype and social jetlag: impact on cognitive abilities and psychiatric disorders. *Biochem Pharmacol*. 2021;191:114438. doi:10.1016/j.bcp.2021.114438
34. Pyper E, Harrington D, Manson H. Do parents' support behaviours predict whether or not their children get sufficient sleep? A cross-sectional study. *BMC Public Health*. 2017;17:1–10. doi:10.1186/s12889-017-4334-4
35. Pillion M, Gradisar M, Bartel K, Whittall H, Kahn M. What's "app"-ning to adolescent sleep? Links between device, app use, and sleep outcomes. *Sleep Med*. 2022;100:174–182. doi:10.1016/j.sleep.2022.08.004
36. Illingworth G, Sharman R, Harvey CJ, Foster RG, Espie CA. The Teensleep study: the effectiveness of a school-based sleep education programme at improving early adolescent sleep. *Sleep Med*. 2020;2:100011.