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School Start Times in South Carolina and New York: Associations with Academic Achievement

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Abstract

Early school start times have been implicated in the sleep restriction of students, and many school districts across the country have begun to delay start times for middle and high schools 3. However, several gaps in this research remain. Implications of early start times for elementary school students are understudied, and most research focuses on just one or two schools. The purpose of this research project is to examine possible implications of early start times on all public elementary schools within the states of: Mississippi, South Carolina, and New York. We hypothesize that earlier school start times will be associated with lower standardized test scores. Including Demographic information about the schools: student teacher ratio, number of students receiving free or reduced lunch, percent of students who are African American and Hispanic, enrollment size, and grade levels will be obtained from the Department of Education website. Start times will be obtained by calling school offices. Data will be analyzed to determine if there is an association between earlier school start times and lower standardized test scores. Findings will contribute to the very small number of studies on elementary school start times and will inform policy changes for school start times more broadly.

Keywords: School Start Times, Sleep Restriction, Education

1. Introduction

Sleep is extremely important for the health and wellbeing of children. Inadequate sleep is associated with poor concentration, increased risk of obesity, impaired achievements in education, and depression 13. Therefore, it is vital to understand factors that may hinder sleep for children. One of the many factors that may hinder sleep are school start times 7. Students must wake up early enough to be ready and transported to school, thus early school start times can contribute to sleep deprivation among adolescents 8. However, there are few studies that examine the potential implications of early school start times for elementary school students. Thus, the aim of the current study was to address this gap by examining associations between the start times of public elementary schools and school performance measures within the states of South Carolina and New York.

Research has documented that school start times can contribute to insufficient sleep in adolescents. In fact, one study found that students in sixth through tenth grades that went to a school with a 9:30 AM start time compared with an 8:30AM start time had a seven percent lower probability of feeling tired at school in the mornings 7. In addition, a 30-minute delay in a high school start time from 8:00 AM to 8:30 AM documented a 45-minute increase in sleep duration during school nights 17. Ironically, the high school students self-reported going to bed earlier after the change in school start time thus relating to the 45-minute increase in sleep 17 .

Studies have been conducted to further examine the relationship between sleep quality and school performance 14. One study found that high school students who went to bed at 11:30 pm or later had more difficulties preparing for exams and completing homework than the students that went to sleep at 10:00pm or earlier 13. Later bed times, overall

poor sleep quality, and sporadic sleep schedules are negatively associated with school performance for students in middle school through college 20 .

Considering that early school start times restrict student sleep, early school start times may also hinder academic performance. For example, it was found that a change in a high school start time from 7:15 am to 8:40 am resulted in an increase in attendance rate from 72% to 76% [24]. However, this evidence is derived almost exclusively from studies of adolescents. One of the reasons for the focus on adolescents is due to important biological changes in sleep/wake regulation that occur during puberty 5. These include a diminished homeostatic influence, reducing the pressure to sleep that builds as persons are awake for longer periods of time, and a decreased sensitivity to light and dark changes 5.

As a result, adolescents experience a phase shift in the timing of their sleep, going to bed later and waking up later. Based on these findings, many school districts across the nation have already begun to delay start times for middle and high school students. This is often achieved by making elementary schools start earlier to maintain staggered bus schedules, so the same buses can serve all of the students 9. For example, Fayette County, Kentucky moved a few elementary schools to a 7:30 AM start time 25. In addition, Wilton Connecticut moved some elementary schools to a 7:35 AM start time 26.

Therefore, it is important to research the potential implications early school start times may have on elementary school children. One study found that earlier school start times were related to lower school performance mostly for elementary schools with fewer students receiving free or reduced lunch 11. These findings illustrate that earlier school start times can be associated with poorer school performance in elementary schools for at least middle and upper-class students; schools with higher percentages of economically disadvantaged students were less likely to perform better in school if their start times were later 11. Thus, socioeconomic status is a moderator of the association between school start times and academic success.

This economic gap in the potential benefit of later school start times may be due to an accumulation of risk among lower income populations. Children in low income families face challenges such as; low parental monitoring [10], less parental involvement within the school systems 1 , and less highly trained teachers 4. In addition, there are many potential obstacles to healthy sleep in low income families including less comfortable bedding, less comfortable room temperatures, noise, and sharing rooms 2. Thus, changing only one factor (i.e.: school start time) may have little impact on child academic outcomes.

The current study expands the previous Kentucky work by examining two new states: South Carolina and New York 11 . The current study aims to examine whether the previous findings within Kentucky can be replicated in a larger and more economically unequal state such as New York 11. The state of New York leads the nation in income inequality 19. There is literature that documents the gap in achievement between poor students and their middle-class counterparts. There are likely many reasons for this achievement gap, including the inability to afford costly extracurricular activities that may enhance cognitive development 6. In addition, another reason may be that children from a lower economic status also receive poor sleep 2.

The current study also examines whether the findings within Kentucky can be replicated in a lower achieving state such as South Carolina. South Carolina ranked 50th in the nation for state school performance 13. Thus, this study strives to explore if early school start times have an impact in low academically achieving states such as South Carolina. It is hypothesized that earlier school start times will be associated with lower standardized test scores in both South Carolina and New York.

2. Method

2.1 Basic Demographics

School start times were collected by either calling the school's office or visiting the school's website. The following basic demographic information was collected for all public elementary schools in both New York and South Carolina: rural or urban, free and reduced cost lunch, teacher/student ratio, percent Hispanic, percent African American, enrollment, and school district. A school was designated as rural or urban based on the locale codes from the National Center for Education Statistics website. Free and reduced cost lunch was assessed by the total number of students in the school receiving free or reduced cost lunch. Student-teacher ratio was defined as the average number of students per teacher. Percent African American was defined as the percentage of students in the school that are African American, and percent Hispanic was defined by the percentage of students in the school that are Hispanic. Enrollment

was defined as the total number of students enrolled in the school, and the school district was defined as the school district in which the school lies in.

2.2 Exclusions And Ineligibility

There was a total of 667 public elementary schools within the state of South Carolina included in the analyses. Elementary schools were excluded if the schools were classified as vocational, alternative, private, or special education schools. In addition, elementary schools were excluded if the elementary school was currently not operational. The list of public elementary schools within the state of South Carolina was downloaded from the National Center for Education Statistics website. There were a total of 2633 public elementary schools within the state of New York included in the final analyses. Elementary schools were excluded from analyses if the schools were classified as vocational, alternative, private, or special education schools. Schools that were currently not operational were also excluded from analyses. In addition, schools that did not list their school start time online and refused to reveal their school start time by phone were excluded.

2.2 State Specific Variables

Different variables were available for South Carolina. For example, within South Carolina the percent of students served by Gifted and Talented Programs was available. This variable was unique to the state of South Carolina and included in the final analysis.

2.3 Proficiency Scores

Proficiency scores differentiate between states. South Carolina proficiency scores evaluated the students' performance based on the South Carolina College and Career Ready Assessments (SC Ready) for the 2015-2016 school year. These were obtained from the South Carolina Department of Education website 16. Proficiency in South Carolina was defined as the percent of students that "Exceeds Expectations" and "Meets Expectations." Third grade proficiency scores were available for English and Math. Fourth grade proficiency scores were available for Math, English, Science, and Social Studies. Fifth grade proficiency scores were available for Math, English, Science, and Social Studies. New York had a database on the New York State Department of Education 14. It contained assessment data for grades third, fourth, and fifth in English Language Arts and Mathematics from the 2016-2017 school year. There was no Social Studies exam for the 2016-2017 school year as the last one was administered in the 2009-2010 school year. Proficiency was defined as proficient and above proficient.

3. Results

3.1 Data Analyses

It was hypothesized that earlier school start times would be associated with lower standardized test scores. In order to test this hypothesis, the first step was to evaluate the dependent variables for evidence of nesting. The dependent variables were the proficiency scores. Evidence of nesting was present, and intraclass correlations ranged from .15 to .36 within the South Carolina data set. The intraclass correlations within the New York data set ranged from .25 to .67. These intraclass correlations indicated significant nesting and the need for multi-level modeling.

Evaluation of the dependent variables indicated that there was significant skew in most proficiency score measures in both South Carolina and New York. Several nonlinear transformations were used to address the skew. However, there were no nonlinear transformations that results in non-skewed variables. For this reason, the original variables were used in models.

For both New York and South Carolina, the independent variables of interest were: school start time and interactions between school start time and percent of students receiving free or reduced cost lunch or percent of students that were African American. These variables were grand mean centered. All models controlled for the number of students enrolled, the teacher student ratio, the percent of students who were African American, the percent of students who were Hispanic, the percent of students receiving free or reduced cost lunch, and whether the school was in rural or

urban community. In South Carolina, data were also available on the percent of students who were classified as gifted, and this variable was also included as a control variable.

3.2 Descriptive Statistics

The average start time in South Carolina was 7:46 AM and ranged from 6:45 AM (n = 1 school) to 9:00 AM (n=1 school). There were 453 schools starting before 8 AM, an additional 209 schools starting between 8:00 AM and 8:30 AM. The mean proficiency scores within South Carolina ranged from 63.39% (4th grade Science) to 80.32% (4th grade Social Studies). However, it ranged from 3.9% to 22.4% of schools that had less than 50% of students score proficient or above on each test.

The average start time in New York was 8:25 AM and ranged from 7:00 AM (n = 4 schools) to 9:55 AM (n=1 school). There were 256 schools starting before 8 AM, an additional 1379 schools starting between 8:00 AM and 8:30 AM. The mean proficiency scores within New York ranged from 35.44 (5th Grade English) to 48.65 (3rd Grade Math). However, it ranged from 60.2% to 77.0% of schools that had less than 50% of students score.

3.3 School Start Times

Only two significant interactions were found within the South Carolina data. No significant main effects were found. A significant interaction was found between school start time and the percentage of black students in predicting 3rd grade math proficiency and between school start time and rural schools in predicting 5th grade math proficiency.
All tested interactions were significant within the New York data. In all cases except for 5th grade Math proficiency, the average association between school start time and achievement was significant and negative. Thus, later school start time was related to lower 3rd grade English and Math proficiency scores, lower 4th grade English and Math proficiency scores, and lower 5th grade English proficiency scores. These negative associations became more strongly negative for schools with a higher percentage of students receiving free or reduced cost lunches as indicated in table 1. Similarly, negative associations between school start times and proficiency scores became more negative for schools serving a higher percentage of black students as indicated in table 2. Our data is consistent with percent of students receiving free or reduced cost lunch being a moderator. In addition, our data is consistent with the percent of students in the school who are black being a moderator.

3.4 Tables

Table 1. Models results for predicting english and math proficiency scores in New York

Variable	3rd Grade ELA	3rd Grade Math	4th Grade ELA	4th Grade Math	5th Grade ELA	5th Grade Math
Enrollment	-.00001	-.00000809	-00000448	.000029*	.000004019	.000025
% Black	-.00002	-.00073 **	.000156	-.0010***	-.00036	-.00166***
% Latino	.000053	-.00031	-.00025	-.00101***	-.00020	-.0083
TS Ratio	.000584	.000487	.000311	.000539	.000629	.000382
Urban	.09128***	.05266***	.09600***	.07563***	.07628***	.07296***
% Free	-.00409***	-0.00345***	-.00399***	-.00352***	-.00406***	-.00361***
Start Time	-.00066***	-.00081***	-.0053***	-.0059***	-.00036**	-.00025
Start X % Free	-.00002***	-.00002***	-.00002***	-.00002***	-.00001**	-.00002**

Note. TS Ratio = Teacher Student Ratio. % Free = Percentage of students receiving free or reduced cost lunch. Start X % Free = Interaction between school start time and percent of students receiving free or reduced cost lunch.
*p <. 05. **p <. 01. ***p <. 0001

Table 2. Model results for predicting english and math proficiency scores in New York

Variable	3rd Grade ELA	3rd Grade Math	4th Grade ELA	4th Grade Math	5th Grade ELA	5th Grade Math
Enrollment	-00002	-.00001	-.000002354	.000026	-.000003467	.000024
% Black	-.00049*	-.00132**	-.00026	-.00142***	-00055**	-.00202***
%Hispanic	.000134	-.00021	-.00019	-.00094***	-.00018	-.00079**
TS Ratio	.000544	.000432	.000277	.000498	.000584	.00305
Urban	.08976***	.04960**	.09418***	.07305***	.07596***	.07100***
% Free	-.00398***	-.00333***	-.00389***	-.00344***	-.00400***	-.00349***
Start Time	-.00058***	-.00073***	-.00046**	-.00051***	-.00031*	-.00017
Start X % Black	-.00003***	-.00004***	-.00003***	-.00003***	-.00001**	-.00002***

Notes. TS Ratio = Teacher Student Ratio. % Free = Percentage of students receiving free or reduced cost lunch. Start X % Black = Interaction between school start time and percent of black students. *p <. 05. **p <. 01. ***p <. 0001

4. Discussion

Only one study to our knowledge has studied the associations between elementary school start times and academic performance on a statewide level 11. The current study investigated relations between elementary school start times and proficiency scores within public elementary schools in South Carolina and New York. The main hypothesis was that earlier school start times would be associated with lower standardized proficiency scores. Unexpectedly, few associations were found for South Carolina. For New York, there were average negative associations between school start times and 3rd grade Math and English, 4th grade Math and English, and 5th grade English proficiency. Furthermore, associations were even more strongly negative for schools with a higher percentage of students receiving free or reduced cost lunches and for schools serving a higher percentage of black students.

The negative associations between school start times and elementary school achievement outcomes were unexpected. These findings indicate that early school start times may be beneficial for young students while later school start times may be harmful upon controlling for a variety of school characteristics. There are numerous potential explanations for such findings.

One potential explanation for why the results of this study suggested later school start times may be harmful for students is because most of these elementary school children are not experiencing puberty. The onset of puberty is typically age 11 in girls and age 13 in boys, but the onset of puberty varies from individual to individual 15. One of the main arguments against delaying elementary school start times is because elementary school children do not experience the circadian phase delay 21. The circadian phase delay is specific to adolescents in particular 21. This could relate to the finding that later school start times may not be as beneficial for elementary school students as these elementary school students are not experiencing the phase delay.

The results of the current study are inconsistent with the previous study on elementary school start times in Kentucky 11. It is unclear as to why there would be such discrepancies between the findings from New York, South Carolina, and Kentucky as opposite findings were observed between New York and South Carolina compared to Kentucky. However, New York has numerous economic disparities as it ranks number one in the nation in economic inequality 19. The economic disparities present in New York may relate to such opposite findings compared to the Kentucky findings. Thus, a delay in school start time may not be sufficient to overcome the numerous other obstacles that extremely economically diverse states such as New York face.

Within South Carolina, only two significant interactions were observed out of the numerous interactions tested. Potential reasons for this lack of many significant findings within South Carolina can be due to the fact that South Carolina had fewer schools compared to the state of New York. A larger sample size is needed for more statistical power. Therefore, the lack of a large sample size of schools within South Carolina can potentially explain the reason for such few significant findings. In addition, 406 schools started before 8:00 AM in South Carolina. However, only 256 schools out of 2633 within the state of New York started before 8:00 AM. The standard deviation for school start time in South Carolina was 15 minutes whereas the standard deviation for school start time in New York was 29 minutes. The standard deviation for school start time in New York was almost double that of South Carolina. Therefore, South Carolina did not have much variability between school start times. This could potentially explain

why many significant interactions were not found since there was not much variability between the school start times to begin with. In addition, South Carolina is a low achieving state. There are numerous challenges that arise within low achieving states. Therefore, later school start times may not be as helpful when such areas are facing so many other challenges.

These findings should be interpreted in light of current limitations. This current study did not include middle and high schools; policy implications cannot be identified without comparing these results to those for middle and high schools. Although we controlled for a number of potential confounding factors, including the racial composition of the schools and teacher-student ratio, we cannot infer that early school start times were the cause of school proficiency score. Another limitation is the study had a correlational cross-sectional design and there was not a nonlinear transformation that addressed the skew across the dependent variables. In addition, such findings may not generalize to other states as finding were different within New York and South Carolina compared to Kentucky. Another limitation was the fact that there was not a nonlinear transformation that addressed the skew across the dependent variables.

Despite these limitations, this study adds to the field regarding our understanding of the potential role of school start times on academic achievement. Unexpectedly, this study demonstrated that there are associations between later school start times and school performance. In conclusion, it is likely premature for policy makers to be dramatically changing start times for elementary school students until more research is conducted within several different states regarding elementary school start times.

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