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SCHOOL START TIME AND PSYCHOLOGICAL HEALTH IN ADOLESCENTS

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Abstract

PURPOSE OF REVIEW: Later school start times are associated with a number of benefits for adolescents. The purpose of the current review is to summarize the literature regarding the effects of delaying school start times on adolescent psychological health.

RECENT FINDINGS: We identified eight observational studies that examined the relationship between schools' starting times and psychological outcomes. Of these, three were longitudinal studies that reported measures of adolescent mental health improved following a start time delay. Two cross-sectional studies showed that mental health scores were higher in schools with later compared to earlier start times. Three studies found no relationship between start time and mental health.

SUMMARY: In the majority of studies reviewed, later school start times were associated with greater adolescent psychological health. However, inherent design drawbacks in the studies prevent us from concluding that these associations are causal. There are a wide range of potential benefits, beyond mental health, that later high school start times offer. This encouraging, emergent literature on delayed start times has led many school districts to consider changes to their start times.

Keywords

sleep; mental health; adolescent health; schools; public policy

Introduction

Sleep problems, including chronic sleep insufficiency, insomnia, and circadian rhythm disruption contribute to adverse outcomes in adolescents, including increased risk for physical and mental health problems, hazardous behaviors, and poorer school performance [1]. National surveillance shows that only 7% of US adolescents report optimal sleep (at

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Conflict of Interest

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least 8.5 hours) on school nights [2]. Alarming, adolescent sleep has declined over the last 20 years; a trend that has been called a “great sleep recession [3].”

Many factors may contribute to the high prevalence of adolescent sleep problems, including social pressures to stay up late, screens around (and after) bedtime, and caffeine use, to name a few. However, even in the absence of these social and environmental contexts there are powerful, hardwired biological factors that push teenagers toward later bedtimes and delayed wake-up times. Around the time of puberty, adolescents experience a shift in their sleep-wake cycles, which is driven primarily by a delay in the release of the hormone, melatonin [4]. Early high school start times, which are incompatible with this neurobiologically driven circadian reality that most teens experience, have a direct impact on the quality and quantity of adolescent sleep [1, 5].

Early school start times and resulting sleep curtailment and circadian misalignment, in turn, could set the stage for increased risk for adverse mental health problems, with lasting consequences for adolescent health and functioning. If this is the case, schools’ start times could have even broader implications for healthy youth development as poor mental health among adolescents is an incredibly important public health problem [6, 7].

Roughly 13% to 20% of US children experience a mental disorder each year in the US, with an annual cost of treatment for all persons aged under 24 years of \$247 billion [6]. From 2005 to 2015, the US-nationally representative National Survey on Drug Use and Health (NSDUH) revealed that the prevalence of depression among adolescents increased from 8.9% to 12.7%, which is over three times greater than the increase seen in the entire U.S. population [7]. Furthermore, 50% of all lifetime cases of depression begin by age 14 [8]. Thus, adolescence may be a critical period for preventing the lasting consequences of mental health morbidity and improving sleep health may be a key tactic in the armament of psychological health promotion strategies.

Numerous observational studies have demonstrated links between sleep problems and adverse psychological and behavioral outcomes. Sleep disturbances and psychiatric mood disorders such as major depression and post-traumatic stress disorder commonly co-occur in adults [9]; further, there is evidence that sleep problems can predict the onset of new mental health problems, including depression [10, 11], PTSD [12], and even suicide [11]. During the teen years, individuals who get inadequate sleep or who have poor quality sleep are more likely to report symptoms of depression [13], hopelessness and suicidal thoughts and attempts [13–15], irritability and impaired emotional regulation [16]. Additionally, sleep problems, including insomnia, short sleep duration, and inconsistencies in weekend versus weekday sleep timing (an indicator of circadian misalignment) are associated cross-sectionally and longitudinally with increased use of alcohol, marijuana, and other drugs in adolescent samples [13, 15].

Evidence from experimental studies of sleep restriction provides further causal support for a role of sleep disturbance in contributing to mental health problems. Several randomized experimental studies of adolescents have evaluated the association between sleep restriction or extension and affect or mood [16–18]. Compared with periods of extended sleep, sleep

restricted adolescents have higher levels of anxiety, anger, fatigue and confusion [16]. Sleep trials examining mood response in adolescents show sleep deprivation to be associated with reduced positive affect [17, 18], and increased negative affect [17], which may serve as a vulnerability to depression. These changes in affective response may be due to the role played by REM sleep in emotional processing [9], particularly when adolescents are woken prematurely and thus deprived of rapid eye movement (REM) sleep; the stage of sleep that is known to be associated with emotional processing. This deficit hampers recovery from emotional conflict, and reduces emotional control by increasing reactivity to negative emotional stimuli [9].

Based on the empirical evidence demonstrating the benefits of later school start times, multiple organizations and agencies including the American Academy of Pediatrics and the Centers for Disease Control and Prevention, have recommended that middle and high schools start no earlier than 8:30 am to support adolescent sleep, learning, and general health [1, 5, 19]. The literature lists many benefits to delayed high school start times, including improvements in sleep, attendance and graduation rates, and safety [20–22], however there has not been a systematic appraisal of the evidence linking high school starts to mental health. The purpose of the present article is to review the literature specifically examining the links between school start times and mental health outcomes.

Literature Review Search Methods

Articles were identified through searches first of Ovid® Medline, then Ovid® PsycINFO, then ERIC via EBSCOhost. To be included in the literature review from these searches, studies had to be peer-reviewed, include a K-12 school start time contrast as the exposure (e.g. comparing two or more schools with different start times, or comparing one school before and after a start time change) and a psychologically relevant measure as an outcome (e.g. positive and negative affect, substance use). We did not restrict the search with a data range. The search terms were as follows:

Medline and PsycINFO search: ((“school start time*” .mp. OR “start time*” .mp. OR “school schedule*” .mp.) AND (psych* .mp. OR “mental health” .mp. OR exp Mental Health/ OR mood .mp. OR exp Emotional States/ OR depress* .mp. OR exp Major Depression/ OR anxi* .mp. OR exp Anxiety/ OR exp Mental Disorders/ OR “substance use” .mp. OR exp Drug Abuse/ OR exp Drug Usage/ OR drug* .mp. OR alcohol .mp. OR tobacco .mp.))

ERIC vis EBSCOhost search: (“school start time*” OR “start time*” OR “school schedule*”) AND (psych* OR “mental health” OR mood OR “emotional states” OR depress* OR anxi* OR “mental disorder*” OR “substance use” OR drug* OR alcohol OR tobacco)

Titles and abstracts were reviewed to identify studies that may be eligible for inclusion criteria; a full text review confirmed eligibility. We also searched the gray literature by consulting subject matter experts. To identify any additional eligible articles, we examined the references of articles and systematic reviews included from the above searches.

Literature Review Results

The search of Medline returned 225 results, of which five studies [23–27] were eligible for inclusion. The subsequent PsycINFO search returned 111 results, of which one study [28] was both eligible for inclusion and not previously identified. The final database search (ERIC) returned 116 results, though all had been identified by one or both of the prior searches. Two additional eligible studies [29, 30] were identified through their inclusion in a recent systematic review [21].

The search yielded a total of eight studies that were included in this review (Table 1). There were two additional studies that otherwise would have met our inclusion criteria, but did not present estimates of the total effects of school start time on psychological wellbeing [31, 32]. Thacher and Onyper conducted a longitudinal study before and after a start time delay from 7:45am to 8:30am [31]. Although they included depression, anxiety, and stress as outcomes of school start time delay, the models were adjusted for sleep duration and circadian preference, which are hypothesized mediators of the effect of school start time on psychological wellbeing. Therefore, the measure of association provided is the direct effect of start time (i.e. that which is not mediated by sleep), which would be expected to be attenuated relative to the total effect of start time [33]. Peltz, Rogge, Connolly and O'Connor conducted a cross-sectional study [32] to examine the direct and indirect paths between sleep hygiene, school start times and mental health. The study was excluded because it does not include a model designed to assess the total effects of school start time on psychological wellbeing.

Psychological effects of delayed school start time

Of the eight studies identified in the literature search, five showed a significant association between school start time and a mental health outcome, and the remaining three did not find statistically significant associations. However, there was considerable variability in the types of mental health outcomes evaluated as well as the study design. The most commonly measured outcome was depression and/or anxiety symptoms, which were included in four studies [23, 25, 29, 30]. Positive and negative affect or attitudes towards life were measured in two studies [24, 28]. Two studies measured behavioral difficulties and included general measures of mental health [26, 27]. Therefore, we summarize the findings in three sections, including studies that evaluate the association between school start times and: 1) depression and anxiety; 2) positive or negative affect; and 3) behavioral health.

Depression and anxiety

All four studies that included depression and/or anxiety as outcomes found that students in later starting schools showed fewer symptoms of depression than students in earlier starting schools.

Two studies focused on the cross-sectional associations between later-school start times and depression, were conducted by Wahlstrom in demographically similar schools in Minnesota; both found that later start times were associated with fewer depressive symptoms [29, 30]. In the first of these studies [29], 7,168 students in grades 7 and 8, and high schools, in grades

10 to 12, in three Minnesota school districts with different start times completed the School Sleep Habits Survey. The School Sleep Habits Survey includes the six-item Kandel-Davies depressive symptoms scale, which was developed for use in a comprehensive high school setting [34]. The high schools started at 8:40am, 7:30am, and 7:15am, while the middle schools started at 7:35am, 8:30am, and 8:30am, respectively (i.e., the district with the latest-starting high school had the earliest-starting middle school). Wahlstrom found that students at the latest-starting high school had significantly more sleep than students at either earlier-starting high school [29]. Average depressive symptoms scores were significantly lower at the latest-starting high school compared to the earliest-starting high school, but were not significantly lower than at the school starting at 7:30am [29]. In addition, middle school students at the earliest-starting middle school had depressive symptoms scores significantly higher than one, but not both, later-starting middle schools [29]. However, there was not a significant difference in sleep duration between the earliest-starting middle school and the school with which its depressive symptoms scores differed [29].

In the second of these studies, Wahlstrom conducted a cross-sectional study comparing 467 students in grades 9 to 12 in the Minneapolis school district to 169 students in an demographically-similar comparison urban high school [30]. The Minneapolis students, who had an 8:40am start time, completed the School Sleep Habits Survey in 1997 and 2001, while students in the comparison school, with a 7:30am start time, were surveyed only in 1997. The Minneapolis results from both years were pooled for analysis. The Minneapolis students had depressive symptoms scores significantly lower, and sleep duration significantly longer, than those in the comparison district [30]; however, the lack of repeated assessments of depressive symptoms in the comparison school is a notable limitation. Furthermore, another important limitation of the Wahlstrom studies is that neither study controlled for potentially confounding school- or district-level variables, such as community SES or school health center funding, that may themselves be associated with different levels of depression.

Two longitudinal before-after studies assessed changes in depressive symptoms in high schools following a delay in school start times [23, 25]. Owens, Belon, and Moss conducted a longitudinal study in a Rhode Island boarding school that temporarily delayed its start time from 8:00am to 8:30am between January 6 and March 6, 2009 [23]. Students in grades 9 to 12 completed the School Sleep Habits Survey in December, before the start time delay (N = 225), and a follow-up survey in March (N = 201), after the start time had been delayed for two months. The study found that following the thirty-minute delay in start time, students reported significantly longer sleep durations and significantly lower levels of depressive symptoms. Furthermore, depressive symptoms were negatively correlated with sleep duration. One limitation of this study is that, although it was designed as a before-after study of the same group of students, the surveys did not contain consistent IDs to allow initial and follow-up surveys from the same student to be matched. Because of this, some students answered surveys at one time but not both, and the authors used independent-sample methods [23]. While the loss of 24 respondents could have led to biased estimates, the independent statistical tests should have produced a more conservative confidence interval compared to paired-sample tests.

Boergers, Gable and Owens conducted another study in a Rhode Island boarding school that temporarily delayed its start time from 8:00am to 8:25am during its winter term [25]. Students in grades 9 to 12 completed the School Sleep Habits Survey in November, before the start time delay (N = 396), and in March, after the start time had been delayed for three months (N = 228). Analyses were restricted to students who completed the survey both times (N = 197). Depressive symptoms decreased, and school-night sleep duration increased, from baseline to follow-up [25]. In addition, school-night sleep duration increased from baseline to follow-up. Sleep was inversely correlated with depressive symptoms at both time points [25].

This longitudinal design is stronger than the previous cross-sectional studies, given that it allows for the examination of whether adolescent mental health changes follow a change in school start times. However, a weakness is that since only a single school was examined in each study, it is difficult to rule out other school-wide factors driving this pre-post change. The observed association of mental health with start time change in the two longitudinal studies is potentially mixed with other causes of change such as seasonal variation [35], community economic factors, or secular trends. A contemporaneous comparison group with a stable school start time would strengthen the design. Such a comparison group would aid in distinguishing the psychological effects of the start time change, if any, from other potential causes of change.

Positive and negative attitudes/affect

Two studies used measures of positive or negative affect; neither finding significant associations between such measures and later school start times. Notably, given the small literature on school start time and psychological health outcomes, we included measures of affect as both positive and negative affect are associated with depression/anxiety symptoms, although they are not considered clinical indicators of mental health, but rather are state-like measures of affective states. Positive affect reflects enthusiasm, activity and alertness; a person with low positive affect feels sadness and lethargy [36]. Negative affect reflects distress and “unpleasurable engagement”; a person with low negative affect feels calm and serene [36].

Vedaa et al. conducted a controlled quasi-experimental study compared positive and negative affect among Norwegian 10th grade students at a school with a delayed start time (9:30am) on Mondays, and an 8:30am start time on other days (N = 55), to a school with an 8:30am start time every day (N = 51) [28]. Positive and negative affect was measured at both schools on a Monday and a Friday, using the Positive and Negative Affect Scale (PANAS) [36] and self-reported sleep duration was also recorded. Students in the delayed Monday start school, slept on average one hour longer on Sunday nights relative to the control school; however, they did not find within group (Monday to Friday) or between-group (delayed Monday versus control school) differences in positive or negative affect. As the authors suggested, the lack of significant associations with affect may reflect the potential confound of timing of assessment (i.e., students affect may improve as the weekend approaches). Of further note, a single day delay in start times is unlikely to have the sustained effects on sleep duration that would be needed to demonstrably influence mental health outcomes. Moreover,

the one day delay in this case was from 8:30 to 9:30am, whereas the average start time in the U.S. is 8:03am [19].

Perkinson-Gloor, Lemola and Grob conducted a cross-sectional study assessing “positive attitude toward life” (e.g., “I am satisfied with how my life plans are getting fulfilled”) among Swiss eighth and ninth grade students whose schools started at 8:00am (N = 2,373) versus 7:40 am (N = 343) [24]. The authors found that even a modest (20 minute) delay in start times was associated with a significant (16 minute) increase in sleep duration; however, there was no significant difference in positive attitude toward life by start time for either male or female students. An important limitation of this study is the limited, two-item assessment of positive attitudes towards life which may not be an indicator of mental health. In addition, the two items were selected from a questionnaire intending for inclusion of eight items to assess positive attitude [37]; it is not clear how the authors selected the items they used and this limited measure has not been validated.

Behavioral health and general mental health

Two studies used measures of behavioral health (such as alcohol use, interpersonal relationships, and conduct problems) and general mental health.

Martin, Gaudreault, Perron and Laberge conducted a cross-sectional study in Saguenay, Quebec, capitalizing on a temporary need to co-house two high schools in one building following a fire that destroyed one of the school buildings [26]. Students from the “home” high school attended a morning “shift” beginning at 7:40am, while students from the “visiting” school attended an afternoon shift beginning at 1:25pm. The researchers recruited 24 morning students and 33 afternoon students, ages 12 to 17, who participated in an actigraphic study and completed a questionnaire that included measures of chronotype, daytime sleepiness, psychological distress, and alcohol consumption. Afternoon scheduled students reported significantly less daytime sleepiness and longer sleep duration than morning scheduled students. No significant association was observed between school start time and either psychological distress or alcohol consumption [26]. While this study does not provide evidence for a start time-psychological health association, it includes students with highly atypical school schedules and in a potentially stressful environment, away from their community high school. In addition, the sample from both schedules was small and self-selected. Indeed, given the sample size and the prevalence of alcohol consumption (7 of 24) and psychological distress (7 of 24) in the morning students, the study was under-powered to detect significant differences.

A longitudinal study by Chan et al. used a broad assessment of measured psychologically-relevant behaviors [27], including conduct, peer relationship problems, emotional problems, hyperactivity/inattention, and pro-social behavior, using the Strengths and Difficulties Questionnaire (SDQ) [38]. Specifically, this study used a controlled quasi-experimental design to compare Hong Kong secondary school students (grades 7 to 11) in a school that delayed start times from 7:45am to 8:00am (N = 617), to students at a school with a consistent, 7:55am, start time throughout the study period (N = 556) [27]. Compared to students in the comparison school, those in the intervention school experienced significant improvements in prosocial behavior, emotional problems, hyperactivity/inattention, and peer

relationship problems, as well as a composite total behavioral difficulties outcome; they did not experience improvement in conduct problems [27]. Composite mental health measured with the GHQ-12 also improved in the intervention school compared to the comparison school [27]. In addition, students at the intervention school reported significant increases in time in bed on both school nights and non-school nights compared to the comparison school [27]. Although the use of a comparison group in this study is an important improvement over uncontrolled before-after studies, the data at the intervention and control schools were collected a half-year apart and may be influenced by seasonal differences in emotional well-being [35].

Conclusions

Advocates of school start time delay frequently cite potential improvements in psychological well-being of children and adolescents as an important reason to delay school start times [1, 5]. A large body of research supports a prospective, bi-directional association between sleep disturbances and poor mental health, and delayed school start times offer a population-level approach to sustained improvements in sleep duration during a critical developmental period. Given the strong evidence linking short sleep duration with mental and behavioral health problems, delaying start times could be an effective population-level strategy to reduce mental health problems in adolescents.

We identified eight studies that examined the association between school start times and psychological wellbeing. Although the literature is small, there appears to be a consistent link between later school start times and greater sleep duration [1], and limited evidence that later school start time might be associated with better mental health, particularly lower levels of depressive symptoms. Our conclusions are tentative as there has been little published in this area and all existing studies reviewed had significant methodological limitations. Five studies found that students at later starting schools had improved psychological wellbeing, while three found no difference. But notably, each study with depressive mood as an outcome found lower levels of depressive mood at later-starting schools. In addition, the three studies that found a null association included a relatively short, 15-minute start time difference [24], a start time delay on only one day of the week [28], and an under-powered study of a highly atypical school schedule [26]. The highest-quality longitudinal studies found improvements in psychological wellbeing following delays in school start time [23, 25, 27].

Inherent design drawbacks in the studies prevent us from concluding that delaying a high school's start time will cause students' mental health to improve. None of the long-term studies we identified included a concurrently measured control group, which is critical for separating the psychological effects of school start time change from seasonal or secular variation or impacts of other policies and interventions on sleep and psychological health. In addition, the range of psychological outcomes that have been evaluated with respect to school start times is narrow and includes non-clinical outcomes such as affective disposition. Outcomes such as substance use and suicidal ideation, which have each been linked to adolescent sleep disturbances, are absent from the literature. Despite these study limitations, it is important to note that no studies identified any negative effects of later start times on

mental health. Furthermore, the existing, albeit limited evidence suggesting that later start times are associated with improvements in mental health symptoms, should be considered in combination with the strong mechanistic evidence demonstrating a causal role of sleep problems, including insufficient sleep duration, circadian rhythm misalignment, and insomnia, in contributing to mood disturbances and the onset and exacerbation of mental health problems in adolescents.

Given the public health impact of poor mental health among adolescents and the lack of other evidence-based population-level strategies to curb the growing rates of mental health problems and sleep disturbances among young people, there is a need for public health policies and interventions that could protect against negative psychological outcomes. High school start time delay is one promising avenue. Momentum for change is increasing across the country, with a greater number of school districts moving to consider later start times [39]. This creates an opportunity for researchers to evaluate these natural experiments and measure the impact of delayed start times on mental health and other outcomes. Measuring control schools, which are not making start time modifications prospectively and concurrently with the schools that do delay start times can alleviate some of the methodological limitations than beset the studies we reviewed here. A strong evidence base is critical to developing prudent policy approaches. Given the known benefits of later high school start times for enhancing sleep and a variety of youth outcomes and the absence of any evidence that later start times have negative effects on student mental health outcomes, school districts and policy-makers should consider supporting later school start times and systematically evaluating the far-reaching effects of such a policy change on adolescent outcomes.

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Table 1.

Studies examining the psychological effects of delayed school start time (SST).

Study/Design	Sample and contrast	Outcomes	Results	Limitations
Wahlstrom, 1998 Cross-sectional	7,168 middle and high school students in Minnesota, USA • High schools: 8:30am vs 7:30am and 7:15am • Middle schools: 8:00am (in 2 schools) vs 7:35am	• Depressive Symptoms Score (School Sleep Habits Survey)	• High school students at 8:30am SST had significantly lower depression score than 7:15am SST, non-significantly lower than 7:30am SST • Middle school students at 7:35am SST had depression score significantly higher than one 8:00am SST, non-significantly higher than other 8:00am SST	• No before-after data are available • No adjustment for potentially confounding variables
Wahlstrom, 2002 Cross-sectional	467 students in Minneapolis, Minnesota, high schools and 169 students in a demographically similar district • 8:40am vs 7:30am	• Depressive Symptoms Score	• Students at 8:40am SST had significantly lower depression scores than 7:30am SST	• Minneapolis surveys from 1997 and 2001 are pooled • Section labeled “Selected Results” raises possibility of publication bias
Owens, Belon and Moss, 2010 Uncontrolled before-after	201 students in a Rhode Island, USA, private boarding school • 8:00am in December vs 8:30am in March	• Depressive Symptoms Score (School Sleep Habits Survey)	• Depression score and percent of students rating self “somewhat unhappy” or “somewhat depressed” lower in March compared to December	• Uncontrolled before-after design does not account for seasonal changes in sleep or mood (e.g. December to March) • Pre-and post-surveys could not be matched, some loss to follow up
Vedaa, Saxvig, and Wilhelmsen-Langeland, 2012 Controlled quasi-experiment	106 Norwegian 10th grade students • 9:30am on Monday and 8:30am on Friday vs 8:30am on both days	• Positive and Negative Affect Schedule (PANAS)	• Delayed SST had no effect on self-reported positive or negative affect	• Short-term comparison window and limited SST delay (Mondays only) limits applicability to permanent schedule changes • Both delayed and early SSTs are later than average in USA • Independent sample tests used – does not account for repeated sampling
Perkinson-Gloor, Lemola and Grob, 2013 Cross-sectional	2,716 Swiss 8th and 9th grade students in lower-track secondary schools • 8:00am vs 7:40am	• Positive attitude toward life	• No differences in positive attitude toward life in male or female students	• Two-item measure of positive attitude toward life may not be valid • Very unbalanced comparison, with less than 13% of students in later-starting schools
Boergers, Gable and Owens, 2014 Uncontrolled before-after	197 students in a Rhode Island private boarding school • 8:00am in November vs 8:25am in March and 8:00am in May	• Depressive Symptoms Score (School Sleep Habits Survey)	• Depression score and percent of students rating self “somewhat unhappy” or “somewhat depressed” lower in March compared to November	• Uncontrolled before-after design does not account for seasonal changes in sleep or mood • Time 3 results are not presented for variables other than sleep duration
Martin, Gaudreault, Perron and Laberge, 2016 Cross-sectional	57 high school students in Saguenay, Canada • 7:40am vs 1:25pm	• Detection of Alcohol and Drug Problems in Adolescents	• No significant difference in alcohol use between morning-	• Models were underpowered to detect difference in prevalence

Study/Design	Sample and contrast	Outcomes	Results	Limitations
		<ul style="list-style-type: none"> • Psychological Distress Index of the Quebec Health Survey (IDPESQ) 	start and afternoon-start students. <ul style="list-style-type: none"> • No significant difference in psychological distress between morning-start and afternoon-start students. 	<ul style="list-style-type: none"> • 1:25pm start time is due to highly unusual circumstance (school fire) and is outside the range of times advocated for in SST interventions
Chan, Zhang, Yu, et al., 2017 Controlled quasi-experiment	1173 Hong Kong secondary school students <ul style="list-style-type: none"> • 7:45am at baseline and 8:00am at follow-up vs 7:55am at baseline and follow-up 	<ul style="list-style-type: none"> • General Health Questionnaire (GHQ-12) to assess mental health • Strengths and Difficulties Questionnaire (SDQ) used to assess behavioral difficulties 	<ul style="list-style-type: none"> • Improvement on mental health, prosocial behavior emotional symptoms, hyperactive/inattention, peer relationship problems, and total difficulties in intervention school compared to comparison school 	<ul style="list-style-type: none"> • Comparison SST was intermediate between pre- and post-change SST for intervention school • Data collection at intervention and comparison schools was a half-year apart; possible seasonal effect