
**M.Sc in Clinical Psychology**
**Department of Psychology**

# Better sleep for teens in Reykjavík – Effects of delaying school start on adolescent sleep

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**Abstract**

The recommended sleep duration for adolescence aged 14 - 17 years old is 8 - 10 hours each night. Studies have shown that Icelandic teens do not meet that recommendation. Multiple studies have shown that delaying school start times may increase sleep duration and well-being for adolescent students. Other studies have discovered that educational programs may also increase sleep duration for teens. The aim of this study was to compare sleep and well-being variables between groups of Icelandic teens receiving these two interventions. Students in 10$^{th}$ grade (aged 14 - 16) from three schools in Reykjavík participated. In the first group, school start was delayed by 40 minutes and a sleep educational program was administered once a week for the school year of 2022-2023. The second group received the same educational program without school start delay and the third was a comparison group. Sleep was measured with sleep diaries, questionnaires, and scan watches, 2 and 6 months after the school start delay and educational program was implemented. Data was compared between groups. Results showed significantly delayed wake up times with no delay in sleep onset times for students with delayed school start. Students with a delayed school start also showed significantly less social jetlag than other groups. Delayed school start time did however not have a significant effect on average sleep duration or well-being. Implications and possible explanations for these results are discussed as well as directions for future research.

*Keywords*: Adolescence, school start delay, sleep education program, sleep duration.

## Introduction

The National sleep foundation recommends 8 - 10 hours of sleep each night for teens aged 14 - 17 years of age (Hirshkowitz et al., 2015). However, a recent national study in Iceland showed that 55% of students in 10$^{th}$ grade (15 - 16 year old) report sleeping 7 hours or less on average per night (Rannsóknir og greining, 2022). Similar results were found when sleep was measured objectively with teens sleeping 6,2 hours on average on school nights and 7,3 hours on non-school nights (Rognvaldsdottir et al., 2017). For teens, sleeping less than the recommended duration has been associated with increased psychological complaints (Norell-Clarke & Hagquist, 2018; Zhang et al., 2017), adverse physical and mental health outcomes (Chaput et al., 2016), and increased risk for developing depression and other psychological problems later in life (Roberts & Duong, 2014; Touchette et al., 2012). Lack of sleep for adolescence has also been associated with poor academic performance, decreased attention and decreased cognitive performance (Agostini et al., 2017; Beebe et al., 2017; Hysing et al., 2016; Lo et al., 2016; Russo et al., 2017; Shochat et al., 2014).

Research from all over the world show a similar pattern, teenagers tend to delay their sleep later into the night (Gradisar et al., 2011). Multiple studies have found that this delay in sleep patterns is caused by changes in the circadian timing system and slowing of sleep homeostatic pressure that leads to delayed onset of sleep for adolescents (Carskadon, 2011; Crowley et al., 2007; Frey et al., 2009). Other possibly stimulating external factors such as use of technology and social networking, self-selected bedtimes and caffeine consumption interact with the biological factors causing a cycle of later sleep onset (Carskadon, 2011; Crowley et al., 2018). This delay of sleep onset paired with early school start is likely to result in teens not getting enough sleep (Carskadon, 2011; Crowley et al., 2018; Kelley et al., 2015; Kirby et al.,

2011; Tarokh et al., 2019). The term social jetlag has been used to describe when individuals compensate for reduced sleep on school or workdays by sleeping more on the weekends when the constraints of society are less likely to influence wake up times (Wittmann et al., 2006). Social jetlag has been associated with worse academic performance (Haraszti et al., 2014), obesity (Parsons et al., 2015) and smoking (Wittmann et al., 2006).

Previous studies have found a correlation between later school start and increased sleep duration for adolescent students (Gariépy et al., 2017; Nahmod et al., 2019; Patte et al., 2017). In recent years multiple studies have been published showing that delaying school start time for this age group increases their sleep duration. This effect has been found in studies using different research designs such as between group design (Fuller & Bastian, 2022) and within group short term effects (Chan et al., 2018; Owens et al., 2017; Winnebeck et al., 2020). Additionally multiple studies have found positive long-term effects of delaying school start (Alfonsi et al., 2020; Boergers et al., 2014; Dunster et al., 2018; Lo et al., 2018). Previous studies have used various methods for measuring sleep such as a questionnaire (PSQI) (Thacher & Onyper, 2016), sleep diaries (Alfonsi et al., 2020; Winnebeck et al., 2020) and smart watches (Dunster et al., 2018; Lo et al., 2018; Nahmod et al., 2019). This effect of increased sleep duration when school start time is delayed has also been established through a meta-analysis (Bowers & Moyer, 2017) and a systematic review (Minges & Redeker, 2016).

Studies show a great variation in increase of sleep duration. Studies that use questionnaire as a measure of sleep show an increase in sleep duration from 27 min (Thacher & Onyper, 2016) to 70 min (Boergers et al., 2014), studies that use a sleep diary show an increase from 34 min (Alfonsi et al., 2020) to 84 min (Winnebeck et al., 2020) and studies that use an objective

measure of sleep show an increase from 13 min (Lo et al., 2018) to 32 min (Dunster et al., 2018) of sleep for every hour of school delay.

Other positive effects of delayed school start have been found such as fewer absences from school (Dunster et al., 2018; Kelley et al., 2017; Wheaton et al., 2016), better academic performance (Alfonsi et al., 2020; Kelley et al., 2017) and improved mental health outcomes (Chan et al., 2018; Thacher & Onyper, 2016) to name a few.

Other interventions to increase sleep duration for adolescence have been tested. One is to educate teens on the importance of sleep and factors that may influence sleep quality. Studies show that most programs have been successful in increasing sleep knowledge (Blunden et al., 2012). Some programs have also been successful in increasing sleep duration for example Kira et. al, (2014) showed that having 4 classes 50 minutes each increased sleep duration by more than 97 minutes on weekends and Illingworth et al., (2020) showed that 10 sessions of 30 minutes each resulted in 9 minutes of additional sleep. Bonnar et al., (2015) showed that self-reported average sleep duration increased by 27 minutes when participants had been through a 4 week program with 50 minute sessions each week. Finally, a meta-analysis found that total sleep time, both on school and non-school nights had increased for students that had received a formal education on the importance of sleep compared to students that had not. The study also found that mood was improved for those students who had received education but that no effects were maintained at follow up (Chung et al., 2017).

In this study the effect of two interventions were evaluated. The first group received an educational program along with a delayed school start of 40 minutes, the second group received an educational program only and the third group was a comparison group that did not receive either intervention. Sleep was measured with smart watches and sleep diaries, at 2 months and 6

months after school delay was implemented and the educational program began. From the literature we hypothesized that sleep duration on school nights would be greatest in the group that received the two interventions and shortest sleep duration would be seen in the comparison group. The increased sleep duration for the group that received a delayed school start was hypothesized to be caused by stable sleep onset and delayed wakening times on school nights. It was also hypothesized that increased sleep duration would result in less fatigue, more morning restfulness, better mood, less stress, less sleepiness and more sleep quality.

## Method

### Participants

Participants were students from three schools in Reykjavík. Consent to participate in the study was signed by the parents or guardians of a total of 104 students (47% female, 0% non-binary). All participants were students in 10$^{th}$ grade in the Icelandic school system, that is between 14 and 16 years old during the study period. No specific exclusion criteria were used to maximize sample size.

**Table 1**

*Participants per group and ratio of class size.*

| | Students per class | Students with parental consent | % of class with parental consent |
|---|---|---|---|
| Group 1 | 43 | 33 | 76% |
| Group 2 | 96 | 56 | 56% |
| Comparison group | 46 | 15 | 32% |

**Procedure**

Three schools in Reykjavík were selected to participate in the study. In the first school (group 1) school start time was delayed from 8:30 to 9:10 each morning for the school year 2022-2023 or by 40 minutes. Additionally, students received an educational program on sleep. The students in the second intervention school received educational program on sleep (group 2) and the students in the third school received no intervention (comparison group). The students in the comparison group and group 2 had a school start time at 8:30 AM.

The educational program was designed by experts in sleep and children's education. The program was designed to fit into the student's current curriculum and focused on the importance of sleep. The students received one lesson (around 40 minutes) per week for the school year 2022 - 2023. For further information on the topics covered in the program see www.betrisvefn.is/namsefni.

Two measures were made, in October 2022 and February 2023. In the 1st measure all groups started data collection in the same week and all groups had normal school schedule. In measure 2, due to practical issues, students in the comparison group started measure one week later than the other groups. Also in between measure 1 and 2 group 1 had to be relocated to a new school building due to maintenance. This changed resulted in classes being held further away from students' homes, outside their residential neighborhood.

For groups 1 and 2 the students that had been granted parental consent for measure 1 were asked to participate in the second measure. Due to the low number of participants in the comparison group additional participants were recruited for measure 2.

The student's legal guardians filled out a consent form for participation in the measures. Participants were asked to fill out a sleep diary and a questionnaire through a mobile app for

seven consecutive days. Additionally, all participants wore Withings Scanwatches that were used to measure sleep objectively. None of the participating students were compensated for their contribution. The study's data gathering was approved by the Icelandic National Bioethics Committee (ref. no. 22-104).

## Measures

### *Questionnaire:*

Students were asked to fill out a sleep diary and other questions in the Sleep Revolution app (Arnardottir et al., 2022). The students were asked to answer the following questions; when they went to bed, when they fell asleep, whether they woke up during the night, when they woke up in the morning, when they left their bed after waking up, if they woke up earlier than intended, if they felt refreshed when they woke up and how they rated the quality of their sleep. There were additional questions asked regarding consumption of alcoholic and caffeinated drinks, use of sleep medication, if they had napped during the day, how much they had exercised and questions regarding fatigue and mood. Not all variables were analyzed in this study.

### *Objective measures of sleep*

Sleep duration was measured objectively with a Withings Scanwatch. The device has received CE medical certification in Europe and FDA clearance in the United States. The ScanWatch was used to measure sleep during the night. Sleep during other times of the day was not used for this analysis. For further information see https://support.withings.com/hc/en-us/articles/360010081658-ScanWatch-Tracking-my-sleep-with-my-watch

### Statistical analysis

Data from the Sleep Revolution app and the Withings databases were gathered and combined in Microsoft Excel. Before analysis the sleep diary and ScanWatch data was cleaned. All recorded sleeping that did not begin and end between 8 in the evening and 8 in the morning was deleted and assumed as naps. School nights were also excluded if wake up time was later than school start time to reduce the influence of sick day and other reasons for increased sleep.

Data was analyzed in SPSS (version 28). Sleep duration was calculated by subtracting wake up time from sleep onset time and exchanged into minutes for both sleep diary and scan watch data. For all analyses a p value of <0,05 was considered significant. Sleep duration was compared between groups with one-way ANOVA. Social jetlag between participants with different school start time was analyzed with an independent sample t-test. Descriptive statistics was used to describe differences in average sleep duration for each participant. Ratio of participants in each group sleeping more than 8 hours on average for each measure, school nights and weekend nights was calculated. Chi square analysis was used to evaluate differences in the ratios between groups. Measures of fatigue, sleepiness, stress, mood, sleep quality and restfulness were compared between groups with one-way ANOVA.

## Results

Sleep duration was measured with a sleep diary. Number of participants and nights recorded per participant in each group can be seen in table 2.

**Table 2**

*Number of participants and average count of nights logged in sleep diary per person for each group, measure 1 and 2 and for school nights (SN) and weekend nights (WN)*

| Group | Measure 1 | | | Measure 2 | | |
|---|---|---|---|---|---|---|
| | Participants (% of class) | SN (max nights) | WN (max nights) | Participants (% of class) | SN (max nights) | WN (max nights) |
| Group 1 | 26 (60%) | 4,0 (5) | 1,5 (2) | 23 (53%) | 3,2 (5) | 1,1 (2) |
| Group 2 | 33 (34%) | 2,0 (4) | 1,5 (2) | 9 (20%) | 1,8 (4) | 1,7 (2) |
| Comparison group | 8 (17%) | 2,6 (4) | 1,9 (2) | 10 (22%) | 2,8 (5) | 1,8 (2) |

*Note.* Max nights refers to total nights measured for each group in each measure.

Average sleep duration as reported in sleep diary for school days and weekend days can be found in table 3. Differences between groups for school nights and weekend nights for each measure were evaluated with ANOVA. No significant differences were found for sleep duration between groups.

**Table 3**

*Average sleep duration in minutes for each group, measure 1 and 2 and for school nights (SN) and weekend nights (WN) reported in sleep diary.*

| Group | Measure 1 | | Measure 2 | |
|---|---|---|---|---|
| | SN (*SD*) | WN (*SD*) | SN (*SD*) | WN (*SD*) |
| Group 1 | 497 (62) | 552 (87) | 472 (71) | 548 (78) |
| Group 2 | 494 (55) | 564 (66) | 487 (46) | 559 (105) |
| Comparison group | 484 (57) | 521 (91) | 443 (60) | 555 (97) |

Correlation between sleep duration measured with sleep diary and sleep duration measured with Withings scan watch was $r(351) = .50$, $p < .001$. Due to the low correlation between the measures only data from the scan watches was used for further analysis.

Number of participants and nights recorded with Withings scan watch per participant in each group can be found in table 4.

**Table 4**

*Number of participants and average count of nights recorded with Withings Scan watch per person for each group, measure 1 and 2 and for school nights (SN) and weekend nights (WN)*

| Group | Measure 1 | | | Measure 2 | | |
|---|---|---|---|---|---|---|
| | Participants (% of class) | SN (max nights) | WN (max nights) | Participants (% of class) | SN (max nights) | WN (max nights) |
| Group 1 | 28 (65%) | 3,1 (5) | 1,8 (2) | 18 (41%) | 3,7 (5) | 2,0 (2) |
| Group 2 | 40 (42%) | 2,6 (4) | 1,9 (2) | 20 (21%) | 2,5 (4) | 1,9 (2) |
| Comparison group | 8 (17%) | 3,6 (4) | 2,0 (2) | 10 (22%) | 3,6 (5) | 1,9 (2) |

*Note.* Max nights refers to total nights measured for each group in each measure.

Table 5 shows the average sleep duration in minutes for each group on school nights and weekend nights for measures 1 and 2 measured with Withings scan watch. One night was excluded for group 2 due to different school start times within the group.

**Table 5**

*Average sleep duration in minutes for each group, measure 1 and 2 and for school nights (SN) and weekend nights (WN).*

| Group | Measure 1 | | Measure 2 | |
|---|---|---|---|---|
| | SN (SD) | WN (SD) | SN (SD) | WN (SD) |
| Group 1 | 483 (85) | 484 (109) | 460 (70) | 563 (74) |
| Group 2 | 454 (70) | 548 (85) | 449 (81) | 547 (81) |
| Comparison group | 499 (116) | 551 (101) | 405 (82) | 577 (117) |

To evaluate the effect of group on sleep duration a one way ANOVA was administered for school nights and weekend nights for each measure. For school nights in measure 1 group had a

significant main effect on sleep duration $F(2,215) = 4,72$, $p = 0,01$. Bonferroni post-hoc test revealed that sleep duration for group 2 ($M = 454$, $SD = 70$) was significantly lower than of comparison group ($M = 499$, $SD = 116$). For school nights in measure 2 group had a significant main effect on sleep duration $F(2,142) = 5,23$, $p = 0,006$. Bonferroni post-hoc test showed that sleep duration for comparison group ($M = 405$, $SD = 82$) was significantly lower than group 1 ($M = 460$, $SD = 70$) and 2 ($M = 449$, $SD = 81$). For weekend nights in measure 1 group had a significant main effect on sleep duration $F(2,122) = 6,124$, $p = 0,003$. Bonferroni post hoc test showed that sleep duration for group 1 ($M = 484$, $SD = 109$) was significantly lower than group 2 ($M = 548$, $SD = 85$). No significant differences were found for sleep duration for weekend nights in measure 2.

Social jetlag was calculated an analyzed. Participants were included if sleep had been recorded for atleast one weekend night and atleast two school nights for either measure. Average sleep duration for school nights and weekend nights was calculated and differences between the two calculated for each participant. The results were analyzed for each group. Groups were combined for increased power, that is students with a later school start time (group 1) were compared to students with earlier school start time (group 2 and comparison group). Results showed that students with later school start time had a social jetlag of 46 minutes on average ($SD = 72$) and students with earlier start time had a social jetlag of 109 minutes on average ($SD = 78$). An independent sample t-test showed a significant difference between the groups $t(66) = -3,243$, $p < 0,001$.

Average sleep duration for each student on school nights was calculated. Data was included if the student had recorded two or more school nights in total. Average sleep duration

per student was grouped by school start time and displayed as ratio per school start time. The results can be found in Figure 1.

**Figure 1**

*Average sleep duration (in hours) on school nights and ratio of group per school start time.*

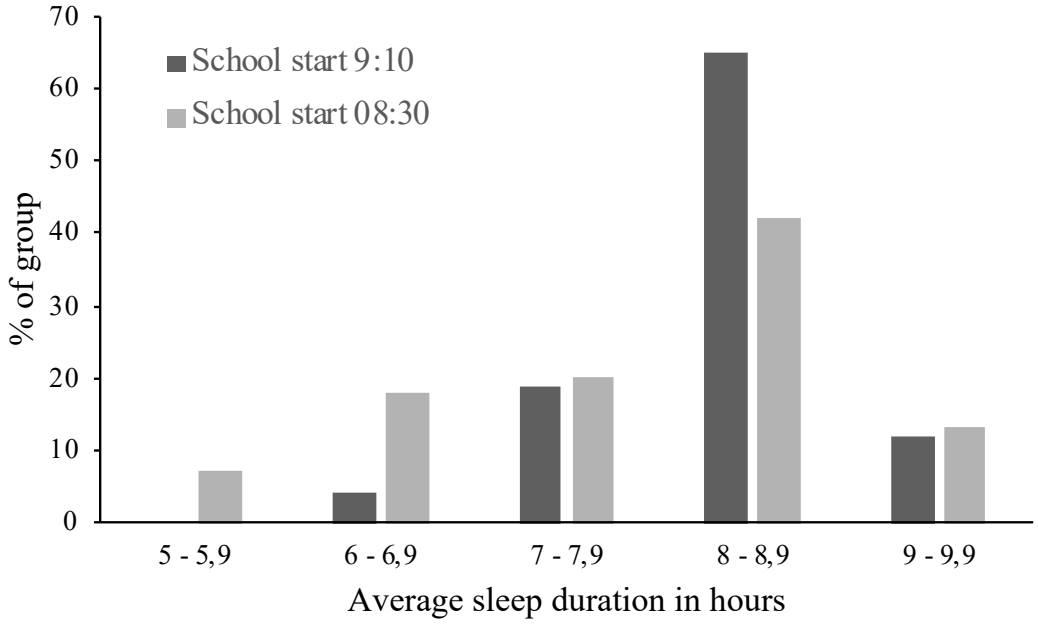


Figure 1 shows that 65% of students that have a later start and 42% of students with earlier school start time sleep on average between 8 and 9 hours. 25% of students with 8:30 start time sleep 7 hours or less on average versus only 4% of students with 9:10 start time.

The ratio of students that get the recommended amount of sleep or more than 8 hours per night for this age group was calculated. Participants were included in the analysis if they had either 2 recorded nights on a school night or 1 recorded weekend night in either measure. Not fulfilling the inclusion criteria for one analysis did not exclude the participant from other

analyses. Chi square analysis showed non significant differences between groups or school start time for school nights.

Times when the Withings scan watches recorded participants falling asleep and waking up on school nights were analyzed. Average time of going to sleep and waking up for each group can be found in table 6.

**Table 6**

*Average time of falling asleep and waking up on school nights for each group.*

| Group | Sleep onset | | Waking up | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| Group 1 | 00:21 | 1:23 | 8:14 | 0:45 |
| Group 2 | 00:08 | 1:01 | 7:41 | 0:41 |
| Comparison group | 23:57 | 1:42 | 7:29 | 0:59 |

No significant differences were found between groups for sleep onset. However ANOVA showed a significant main effect for wake up times $F(2,360) = 2,30$, $p < 0,001$. Bonferroni post-hoc test showed significantly later wake up times for group 1 ($M$ = 8:14, $SD$ = 0:45) than group 2 ($M$ = 7:41, $SD$ = 0:41) and comparison group ($M$ = 7:29, $SD$ = 0:59).

Participants answered questions regarding additional variables on the scale from 0-4 where 0 represented very poor and 4 represented very good. Averages for each group and measure can be found in table 7.

**Table 7**

*Average for each group and measure for additional variables.*

| Variable | Measure 1 | | | Measure 2 | | |
|---|---|---|---|---|---|---|
| | Exp. Group 1 | Exp. Group 2 | Comp. Group | Exp. Group 1 | Exp. Group 2 | Comp. Group |
| Fatigue | 2,85 (0,96) | 2,68 (0,84) | 3,08 (0,97) | 2,58 (0,91) | 2,7 (0,79) | 2,18 (0,95) |
| Sleepiness | 2,82 (0,90) | 2,86 (0,85) | 2,81 (0,95) | 2,85 (0,89) | 2,71 (0,85) | 2,46 (1,07) |
| Stress | 2,9 (1,02) | 2,92 (0,94) | 3,33 (0,89) | 2,88 (0,98) | 3,00 (1,05) | 2,32 (1,02) |
| Mood | 2,83 (0,71) | 2,93 (0,66) | 2,78 (0,87) | 2,61 (0,83) | 2,96 (0,79) | 2,5 (0,79) |
| Sleep quality | 2,7 (0,93) | 2,78 (0,78) | 2,80 (0,90) | 2,63 (0,82) | 2,93 (0,96) | 2,4 (0,92) |
| Restfulness | 2,41 (0,95) | 2,47 (0,87) | 2,51 (1,08) | 2,40 (0,83) | 2,79 (1,04) | 2,15 (1,01) |

Variables were analyzed with one-way ANOVA. In measure 1 analyses show no significant difference between groups for restfulness, sleep quality, sleepiness, stress and mood. Significant differences between groups were found for fatigue, $F(2, 247) = 3.05$, $p=.05$. However, Bonferroni post-hoc test showed no significant differences between groups for fatigue.

In measure 2 analyses show no significant difference between groups for fatigue, sleepiness and mood. Significant difference between groups were found for sleep quality $F(2, 169) = 3,95$, $p =.021$, where Bonferroni post-hoc test revealed that the students in comparison group ($M = 2,4$, $SD = 0,92$) reported significantly less sleep quality than group 2 ($M = 2,93$, $SD = 0,99$), and stress $F(2, 112) = 3.84$, $p = .02$, where Bonferroni post hoc test revealed that students in group 2 reported significantly more stress ($M=3,0$, $SD= 1,05$) than students in comparison group ($M= 2,32$, $SD = 1.02$). Significant differences between groups were also found for restfulness $F(2, 169) = 5.31$, $p = .006$. Bonferroni post hoc test showed that group 2 reported significantly more restfulness ($M= 2,79$, $SD = 1,04$) than group 1 ($M=2,40$, $SD = 0,83$) and comparison group ($M = 2,15$, $SD = 1.01$).

## Discussion

The main purpose of this study was to evaluate the effect of delaying school start and implementing an educational program for adolescent students in elementary schools in Reykjavík. Sleep duration evaluated by sleep diary did not differ between groups for either measure on weekend nights or school nights. This is not in line with the hypothesis or with previous studies. When sleep duration was measured with scan watches the results showed significantly longer sleep duration for comparison group compared to group 2 in measure 1. In the second measure group 1 showed significantly longer sleep duration compared with comparison group. This is not in line with previous studies or the hypotheses where group 1 was hypothesized to have the longest sleep duration compared to both groups that did not receive a school start delay. However, the shortest sleep duration in the second measure was found in comparison group where the students did not receive an educational program and could indicate a positive effect of receiving education on sleep duration. These results should be interpreted with care due to the low number of participants in the comparison group and different results between the two measures.

Differences for each individual between the average sleep duration on school nights and weekend nights, or social jetlag, was shown to be significantly less for students with later start times. This indicates that students with a later school start time do not need to compensate for reduced sleep on school nights by sleeping longer during the weekends. This could explain why non-significant differences were found between groups for average sleep duration.

Analysis of sleep onset and wake up times showed that group 1 had significantly later wake up times with no significant differences in the sleep onset times between the groups. These results are in line with the hypothesis and results found in multiple previous studies (Alfonsi et

al., 2020; Lo et al., 2018; Thacher & Onyper, 2016; Winnebeck et al., 2020). Even though the analysis of average sleep duration for the group was not in line with the hypothesis the pattern of stable sleep onset times and delayed wake up times for students with delayed school start times is similar to what has been found in other studies. Larger samples and more recordings for each participant would be needed to evaluate this effect more thoroughly. The results of the self-report variables analyzed were not in line with the hypothesis or previous studies and no significant positive effects of delaying school start could be found when compared between groups.

The discrepancies between the results of this study and most of the previous studies covered in this paper may be due to different research designs. In most of the previous studies covered in this paper a baseline measure of students' sleep habits was made and the results from the same group compared before and after the introduction of school start delay. Due to practical reasons this was not possible for this study and instead different groups of students receiving different interventions were compared with each other. Any improvement in sleep habits or well-being that has been found in previous studies will not have been recorded with the measures administered in this study. While comparing the different groups may give some indication of the results, important information was lost by not being able to administer a baseline measure and comparison of previous research to the results of this study may not be fair.

The main limitations of the study, in addition to the study design, was low participation rates among students and the different ratio of participation between groups. In group 1 76% of students consented to participate while only 32% of students in the comparison group despite efforts to increase participation in that group. Additionally, a handful of students decided not to participate in the study even though consent had been given. With such difference in participation ratio, it is unlikely that we are seeing the true range of sleep duration for these

groups. When the average sleep on school nights for students in this study is compared to the only previous study that also used objective measures of sleep the average ranges from 6,8 hours to 8,3 hours (see table 5) which is higher than the 6,2 hours in the previous study (Rognvaldsdottir et al., 2017). This could indicate that the students that for some reason do not meet the sleep duration recommendation are not participating in this study. This would in turn effect the study groups differently due to the different class ratio that participated.

Dropout rate and low response rates among participants may also have influenced results. The dropout rate was especially large between measures 1 and 2 where students did not want to participate in the second round of measures. Participants did not receive any forms of compensation or other incentives to give consent or to participate in the study. For this age group this may be needed for future studies to achieve higher rates of participation.

One external factor that most likely influenced the results of the study is the relocation of classes for group 1 due to maintenance of the main school building. The groups classes were moved to a building outside of the residential neighborhood where most of the students lived. This added a considerable commute time for students and likely caused many to not be able to walk to school like before and therefore relying on rides from parents or public transport. This may have an impact on waking times for group 1 and reduce the effect of the delayed school start on sleep duration. Other external factors that could influence the results are low interest in the study from comparison school and different sizes of classes and schools. In Iceland there has also been a great increase in awareness on the importance of sleep and what factors influence sleep. It is likely that most of our participants not only were aware of what was being measured as they gave an informed consent but were also aware of what is assumed optimal behavior. This may cause reactivity and therefore usual behavior not measured.

The study has some theoretical and practical benefits. This is the first study performed in Iceland that evaluates the effect of school start delay and educational programs on adolescent sleep habits. Previous studies have aimed at evaluating the sleeping habits of Icelandic teens without testing interventions. Due to Iceland's unique geographical location and daylight changes that may influence sleep patterns it is important to evaluate interventions that may benefit teens. Another theoretical benefit of the study is the use of sleep diaries to measure sleep habits whereas many of the previous studies have only relied on questionnaires. Sleep was also measured with objective measures, Withings Scan watches, for every participant in the study. Only few studies in the literature have measured sleep objectively.

More research is needed on the effects of school delay and sleep educational programs on the sleep habits of adolescent students. Although multiple studies have evaluated the effect of school delay better and more objective measures are needed to fully evaluate the effects of delaying school start for this age group. More research is also needed on the effects of educational programs on sleep habits and duration.

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