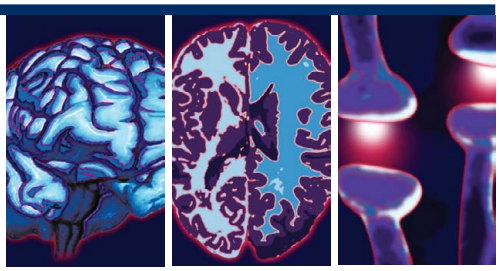

The pilot study of the relationship between the application with the healthy-habits and depressive scores in youth

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ABSTRACT

Background

Insufficient sunlight exposure, high junk food consumption, and sleep deprivation are known risk factors for decreased mental wellbeing, including elevated depressive symptoms and higher suicidality. The aforementioned risk factors for poor mental health are common among Korean adolescents. This study examined the effects of a school-based healthy-habits promotion intervention on depressive symptoms in Korean middle school students.

Methods and Findings

This intervention study with a pre-test/post-test design included 617 middle school students aged 13 to 15 in Seongnam, South Korea from April 2013 to November 2013. The 8-month educational intervention consisted of 3 slogans: 1) Sunlight exposure > 30 minutes a day, 2) No junk food, and 3) Healthy sleep. The primary outcome was depressive symptoms as measured by the Center for Epidemiologic Studies Depression Scale (CES-D). Secondary outcomes included the number of days with sunlight exposure > 30 min/day, junk food consumption in a week, the frequency of staying up late, and problems with sleepiness. After controlling for confounders, the intervention was associated with a significant increase in the number of days of sunlight exposure of > 30 min/day (OR: 4.35, 95% CI: 3.20, 5.91) compared to before intervention. The intervention was associated with reduced odds of elevated depressive symptoms by 35% (OR: 0.65, 95% CI: 0.49, 0.85) compared to before intervention after adjustment for confounders.

Conclusions

These results suggest that school-based educational and behavioral intervention focused on healthy habits may decrease depressive symptoms in adolescents. Findings from our

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study could have significant clinical and public health implications in reducing depressive symptoms among adolescents through behavior and lifestyle changes.

Keywords

School-based, Healthy-habit, Depression, Sunlight exposure, Sleep, Food

Introduction

Adolescence is a period of rapid development of body and mind. Adolescents undergo a dramatic change in sleep pattern, circadian rhythm, and brain function [1]. Large proportions of Korean adolescents have an unhealthy lifestyle due to biological changes and the pressure to perform academically [1-3].

It has been reported that lifestyle factors such as lack of sufficient daily sun exposure, short sleep duration, and poor diet are associated with higher risk of depression [1-3]. Weather, including sunlight, has a strong effect on people's everyday mood and behavior. This is true, even for those who stay indoors all day. According to previous studies, both depressive patients and the non-depressive normal population tend to have elevated depressive symptoms in winter. More precisely, non-depressive individuals often experience depressive symptom in winter [4]. It has been shown that light therapy could be used as an effective method to alleviate this problem [5]. However, the exact mechanism as to how light exposure can reduce depressive symptoms is still unknown.

Diet is another lifestyle factor closely related to mood changes. In a population-based sample, skipping meals or lack of interest in healthy food was associated with elevated depressive symptoms in adolescents. Sixty-five percent of Korean adolescents eat junk foods more than 3 times per week, and this prevalence is a significant increase compared to the prevalence of junk food consumption among Korean adolescents [6,7].

Another lifestyle factor associated with mental health problems is insufficient sleep duration. Short sleep duration can result in poor mental and physical health effects [8]. Furthermore, sleep problems are commonly observed in patients with suicidal ideation, depressive mood, or anxiety [9]. Thus, regular sleep pattern is extremely important for maintaining good mental health. Unfortunately, Korean adolescents tend to have shorter weekday sleep duration than compared to the 8.5 hours of sleep recommended by the America's National Sleep Foundation [10]. Seventy-four percent of Korean adolescents reported not having enough sleep to overcome fatigue [11]. Over 40% of Korean adolescents sleep less than 6 hours sleep per 24 hours [11]. According to previous studies, chronic insufficient sleep during adolescence can be hazardous to their emotional regulation and contribute to poor mental wellbeing. It has been shown that school-based sleep promotion programs can improve adolescent outcomes [12].

In summary, most of Korean adolescents lack healthy behaviors such as getting enough daily exposure to sunlight, limiting junk food consumption, and having sufficient sleep duration. This fact may have contributed to Korea ranking low in the life satisfaction index of 15-year-old adolescents based on the Organization for Economic Cooperation and Development standards [7]. Therefore, we implemented an evident- and school-based healthy-habits promotion campaign to change the aforementioned behaviors that may be associated with adolescent mental well-being. The program aimed to promote healthy habits in adolescents and to help them maintain mental well-being. We hypothesized that our intervention would improve adolescents' daily healthy habits and reduce depressive symptoms

Methods

■ Subjects Ascertainment

This intervention study was conducted as a pilot trial of the mental health promotion program of Seongnam Child and Adolescent Community Mental Health Center ("the Center" hereafter) from April 2013 to November 2013. Seongnam City is a large-sized city in South Korea, with a population of 974,000, including 120,000 adolescents (10~19-year olds) [13]. At the beginning of the school year, we advertised the mental health promotion intervention program to all 39 middle schools and 41 high schools in the city through flyers sent from the City Education Office to invite schools to participate in the intervention program. Two middle schools responded to our invitation and one

was selected as the study site based on the level of understanding and support of the research protocol from the school administrators. The participants are likely representative of the general middle school population in the area considering the co-ed school is located in a typical large-sized city. The student number of students per classroom and grade is not different from the average number of middle school students [13]. Students are randomly allocated to nearby schools. The participating school was not established for special educational purposes such as arts, physical exercise education, science, engineering, or agriculture. We received assent from 700 eligible students in the participating middle school. Pre-test survey and post-test survey were conducted and finally 617 students were contained to our dataset.

■ Procedures

Healthy habit campaign: This intervention study with a pre-test/post-test study design included 617 middle school students aged 13 to 15 in Seongnam, South Korean from 2012 to 2013. Information about the intervention program was shared with students at school and with parents via home correspondence. Written informed consent and assent were obtained from the students and parents. The intervention trial was approved by the Institutional Review Board of Seoul National University Bundang Hospital.

The 8-month educational intervention consisted of 3 slogans: 1) Sunlight exposure > 30 minutes a day, 2) No junk food, and 3) Healthy sleep. The intervention consisted of a 3-hour in-classroom educational session on healthy habits, in-school displays of posters on healthy habits, student participation in a 30-min outdoor activity at lunch break, and student self-reported diaries ("Body-Mind Health Planner") on daily activities, diet, and sleep time. The healthy habit messages from the intervention were supported and reinforced by teachers and the student council. The educational materials regarding sleep hygiene and healthy diet were also included in the "Body-Mind Health Planner". Enrolled students kept track of the junk food and healthy food items they ate each day, the time they went to bed, and the amount of time exposed to the sun. Junk food is defined as food containing high levels of calories with little nutrients such as fast foods and convenience foods. As a reward system, we provided participants an incentive token each time they were involved in lunch hour outdoor activities and completed the daily diary recording. The number of tokens was tallied at the end of the semester and the student council delivered gifts to the individual student as well as to the class with the highest total token count. The healthy sleep, diet, and sun exposure messages and slogans were reinforced as often as possible, by holding posts displayed with campaign slogans in the morning and lunchtime at the school entrance or playground, in addition to distributing campaign flyers and ribbon pins. At the end of the campaign, the students who earned the most tokens were invited to provide feedback and comments about the intervention message on the (study) Center homepage and Facebook page. A number of enrolled students who provided online feedback were randomly selected for a small prize.

Outcome measures: The primary outcome was depressive symptoms as measured by Korean version of the Center for Epidemiologic Studies Depression Scale (CES-D) [14]. The CES-D self-report scale consists of 20 items asking enrolled students about the frequency of their depressed mood, feelings of worthlessness, hopelessness, loneliness, loss of appetite, restless sleep, psychomotor retardation, and concentration problems. Enrolled students were asked to rate how often they experienced each symptom (e.g., sad) in the past week on a 4-point scale, where 0 = rarely or none of the time (less than 1 day), 1 = some or a little of the time (1-2 days), 2 =occasionally or a moderate amount of the time (3-4 days), and 3 = most or all of the time (5-7 days). The response values for each of the four positive items (e.g., happy) were reverse coded and all items summed. The total score may range from 0 to 60. A cut point of 16 was used to create an indicator of having probable depression. A cut point of 25 was used to create an indicator of having definite depression [15]. In our study, a total CES-D sum score that was equal to or greater than 16 was coded as 1, reflecting having elevated depressive symptoms.

There were four secondary outcomes which measure subjects' change of behavior after intervention, as complied with the contents of education. Those include the number of days with sun exposure greater than 30 min/day, the amount of junk food consumption in a week, the frequency of staying up late to at least 3 am, and problems with sleepiness. Frequency of sunlight exposure and junk food consumption variables were coded as follow: 1=never in the last 7 days, 2=once a week, 3=twice a week, 4=three times a week, 5=four times a week, and 6=more than five

times a week. Staying up late was defined that the subject doesn't or can't get sleep until 3 am, regardless of the reason. Frequency of staying up to at least 3 am was coded as follows: 1 = never, 2 = rarely, 3 = about once a week, 4 = a few nights a week, and 5 = every night or almost every night. Degree of problems with sleepiness was coded as follow: 1 = No problem at all, 2 = A little problem, 3= More than a little problem, 4 = A big problem, 5 = A very big problem. Amount of sunlight exposure, staying up to at least 3 AM, and junk food consumption were further dichotomized as 0/1 variables, with values equal or greater than 4 coded as 1. Problems with sleepiness were also dichotomized as a 0/1 variable by collapsing categories with values from 2 to 5.

■ Statistical analyses

Descriptive statistics were estimated for sample characteristics, including frequencies (categorical variables), means (continuous variables), and standard deviations. We used the generalized linear mixed effects model (GLIMMIX) for matched data to compare the outcomes of interest before and after the intervention. Odds ratios (ORs) and 95% confidence intervals (CIs) for the effect of intervention were estimated. To reduce bias in the point estimate, potential confounders were evaluated including health status, physical activity, time spent walking per day, body weight, height, stress, self-reported sleep duration, sex, grade level, and assigned classroom. Only those with a significant p value less than 0.05 were included in the final models, including sex, class (high, low), grade (high, low), and the number of self-reported sleep hours. All calculations were conducted using the GLIMMIX procedure for the clustered data in the SAS software (SAS Institute, Inc., Cary, North Carolina). Results with P-values < 0.05 were considered significant.

Results

Among 617 students, data of 64 participants was excluded from the analysis due to outlier values in the sleep duration measure. When students wrote time went to bed and time woke up, they may confuse 24hr system with 12hr system. Gender distribution was very slightly affected. There was greater proportion of boys than girls who were excluded from the analysis. 51.4% of the students were male before exclusion of outliers and 49% of the students are male after exclusion. However, those who were excluded did not differ from the study sample in grade, class, or CES-D scores. The average class size was 26 students in the study. The average daily sleep was about 7 hours. The CES-D score ranges from 0 to 50 for both pre and post intervention **(Table 1)**. From the primary and secondary outcomes across two time points, there were significant differences in sunlight exposure (p-value<0.0001) and CES-D scores (p-value=0.01) before and after intervention **(Table 2)**. After controlling for the covariates, the odds of sunlight exposure after intervention were 4.35 (aOR: 4.35, 95% CI: 3.20, 5.91). The odds of CES-D after intervention decreased by 35% (aOR: .65, 95% CI: .49, .85) respectively, compared to before intervention. An increase in hours of sleep was associated with decreased odds of staying up late (aOR=.57, 95% CI: .48, .68), having a problem with sleepiness (aOR=.83, 95% CI: .74, .94), and depressive symptoms (aOR=.85, 95% CI: .75, .95). Female students were more likely to have sunlight exposure (aOR=1.87, 95% CI: 1.36, 2.55) and depressive symptoms (aOR=1.61, 95% CI: 1.16, 2.25), and were more likely to consume junk food than before intervention (aOR=1.56, 95% CI: 1.07, 2.26) than male students. Increasing grade level was associated with increased odds of sunlight exposure (aOR=1.23, 95% CI: 1.01, 1.49) and staying up late (aOR=1.75, 95% CI: 1.29, 2.38). Ninety-seven (27%) of the students whose CES-D score was 16 or higher at the baseline, scored lower than 16 after the intervention **(Table 3)**.

Discussion

The present study aimed to evaluate the effects of a school-based mental health promotion program on sunlight exposure, junk food consumption, healthy sleep habits, and depressive symptoms of middle school students. One of the most significant results was that depressive symptoms, measured by CES-D and sunlight exposure time both showed significant improvement after intervention.

It is reported that sunlight exposure reduces depressive symptoms through vitamin D [4,5]. Three cohort studies showed significant increased risk of depression among subjects with vitamin D deficiency compared to those with sufficient vitamin D levels [16]. In the current study, both sunlight exposure time and depressive symptoms were improved after intervention. Increased amount of sunshine might have mediated a decrease in depression.

Ansari et al suggested that participants without depressive symptoms at baseline who consumed trans-fats (pastries and fast food) were at increased risk of depression compared to those who did not [17].

The results from our study, especially gender differences in food-related habits, support previous research about the South Korean middle school students' unhealthy diets and irregular eating patterns. A study among elementary and middle school students by gender in Korea found that female middle school students were the least likely to have healthy foods intake [2]. In the present study, the female students' junk food intake was higher than male students. There were no changes or even increase of junk food consumption in female when students compared to male students. This result may be related to different female students' food intake pattern from male student's pattern. Specifically, female students may frequently eat alone and have snack foods instead of meals [2]. A previous study reported that the frequency of instant food intake didn't change or increased even through nutritional education [18]. The study suggested that short-term education could not easily change the food intake pattern [18]. A multilevel framework for intervention may be needed to alter unhealthy food consumption behaviors among Korean adolescents targeting individual students and their community and parents.

Sleep hours of adolescents in this study were generally consistent with previous research [3,19]. Our study found that the average sleep duration was about 7 hours in adolescents. Higher grade level was a significant risk factor for staying up late and problems with sleepiness. It is plausible that an increase in sleep duration is associated with decreased odds of staying up late, problem with sleepiness, and depressive symptoms measured by CES-D.

Even though the association between sleep problems and depression has been established, the direction of causality is still controversial. Several researchers suggest that sleep deprivation can cause depression [3,8,9,20]. Lee and associates reported that a higher Beck Depression Inventory (BDI) score is predicted among those students with shorter weekday sleep duration, a longer weekend oversleep, a larger weekend bedtime delay, and a larger weekend rise time delay [3]. In a prospective cohort study Glozier et al. found that each hour decrease in total sleep time was associated with a 14% greater risk in psychological distress [21]. Consistent with previous studies, we found that short sleep duration was associated with staying up late, daytime sleepiness and depressive symptoms. Sleep education intervention programs would be critical to reduce circadian rhythm disruption and decrease social jetlag among adolescents [22]. A sleep education intervention could have improved sleep time and wake time of adolescents compared to the control group [3,11,12].

Previous studies had investigated the effectiveness of school-based mental health intervention. In the U.S., students with extremely higher depression scores in the Creating Opportunities for Personal Empowerment (COPE) group presented lower depression scores after intervention compared to the healthy control group [23]. In another study with a pre- and post-test study design, fifteen depressed adolescents presented significant decreased score in depression, anxiety, anger and destructive behavior post COPE program [24]. Our school-based mental health promotion program also obtained positive results in sunlight exposure time and depressive symptom. In this study, we found possibility of applying school based intervention to mental health promotion.

Table 1. Baseline Demographics in Study Sample

		n (%)
Grade		
	1	185 (33.4)
	2	186 (33.6)
	3	182 (32.9)
Gender		
	Males	271 (49.0)
	Females	282 (50.9)
Class size[a]		26.33
Sleep duration[b]		7.02 (1.09)
Total		553

[a] The mean number of students in a class

[b] Mean(Standard Error)

Table 2. Primary and Secondary Outcomes Pre- and Post-intervention

	Baseline n (%)	Follow up n(%)	P-value[a]
	(n=553)	(n=553)	
Sunlight exposure ≥ 30 minutes a day	330(59.7)	468 (84.6)	<0.0001
Junk food consumption in a week	456 (82.5)	466 (83.2)	0.41
Staying up late at least 3AM	56 (10.1)	57 (10.3)	0.92
Problem with sleepiness	153 (27.7)	140 (25.3)	0.40
CES-D ≥ 16	360 (65.1)	317 (57.3)	0.01

CES-D = Center for Epidemiologic Studies Depression Scale

[a] *p* values were based on Chi square test for categorical variables

Table 3. Associations between the Intervention and Adolescent Healthy Behaviors

	Sunlight exposure ≥ 30 minutes a day	Junk food consumption in a week	Staying up late at least 3AM	Problem with sleepiness	CES-D ≥ 16
Factors	aOR (95%CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Intervention (post vs pre)	4.35 (3.20, 5.91)	1.12 (0.80, 1.57)	0.78 (0.50, 1.20)	0.82 (0.62, 1.09)	0.65 (0.49, 0.85)
Class	1.05 (0.97, 1.13)	0.93 (0.85, 1.02)	1.01 (0.90, 1.13)	0.95 (0.88, 1.03)	0.98 (0.91, 1.07)
Grade	1.23 (1.01, 1.49)	1.20 (0.95, 1.51)	1.75 (1.29, 2.38)	1.26 (1.03, 1.53)	1.13 (0.92, 1.40)
Sleep hour	1.05 (0.93, 1.18)	0.94 (0.81, 1.08)	0.57 (0.48, 0.68)	0.83 (0.74, 0.94)	0.85 (0.75, 0.95)
Gender (female vs male)	1.87 (1.36, 2.55)	1.56 (1.07, 2.26)	1.30 (0.82, 2.06)	1.21 (0.88, 1.66)	1.61 (1.16, 2.25)

aOR = adjusted odds ratio; CES-D = Center for Epidemiologic Studies Depression Scale; CI = confidence interval

The strengths of the study lie in the large number of participants relative to previous research. The intervention duration for our study was longer than other adolescent intervention studies [23]. Our study also received great support from the teachers and student governance council which increased the compliance rate. The school-based intervention design is strength of the present study as peer pressure is generally a strong factor in adolescent behavior changes, even more important than the effect of teachers' and parents' opinions. Therefore, school-based programs could be beneficial to modify adolescent behavior.

There are some limitations in the present study. We excluded 64 subjects (10 %) from the analytical samples due to an outlier in the sleep duration measure. Our study findings may be limited by selection bias as a result. Our study lacks family socioeconomic status and household income data; the middle school included in the study might not be representative of Seongnam City or Korea because the socioeconomic status in the selected school was the highest among three areas within Seongnam City [25]. Residual confounding may be likely due to the lack of information on family socioeconomic status, body mass index, psychiatric comorbidity including depressive disorder, and parenting styles. Another limitation of this study is the absence of a control group. Information bias may also be likely with self-report data and students' subjective reporting of the degree of problems with sleepiness but the misclassification error is probably non-differential which would bias our estimate toward the null value. We could not analyze underlying cause and motivation of each behavior, especially in the sleep-related items such as staying up late or total hours of sleep. For about 10 % of subjects, they stayed up to at least 3 AM and they did not change even the application of this program. Although not assessed in our study, these adolescents with self-induced sleep restriction may have addiction in computer games, etc., insomnia or depression. It was hard to differentiate participants who don't want to go to sleep and who have difficulty falling asleep, or staying asleep in our study setting as it was not assessed. A proportion of students (27%) who showed 16 or higher scores on CES-D changed to 15 or lower scores after intervention. However, it is not clear to be interpreted as the effect of intervention itself, as other covariates including treatment history, are not considered.

In conclusion, the 8-month mental health promotion educational intervention program was beneficial to middle school students. We observed a protective effect of intervention on sunlight exposure and depressive symptoms among Korean adolescents. Together our data suggest that increased sleep hour is associated with a decreased frequency of staying up late, having a problem with sleepiness, and depressive symptoms. These results suggest that a school-based educational and behavioral intervention focused on healthy habits may decrease depressive symptoms in adolescents. Multi-center randomized control trials are needed to confirm these findings. If confirmed, findings from our study have significant clinical and public health implications in reducing depressive symptoms among adolescents through behavior and lifestyle changes.

Declaration of Conflicting Interests

The Authors declares that there is no conflict of interest.

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