

Original Research

An Examination of Longitudinal Changes in Korean Middle School Students' Psychological Health According to Their Body Mass Index and Weekly Exercise Hours

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Abstract

Background: It is necessary for adolescents to maintain proper body mass index (BMI) and regular exercise for proper growth, development, and psychological health. Existing studies have demonstrated the significant positive effect of regular physical activity or exercise on preventing socio-psychological problems and cognitive body image issues in adolescents. This study aimed to investigate the longitudinal changes in psychological health factors of mental health, self-concept, self-esteem, and self-efficacy according to BMI and weekly exercise hours among Korean middle school students. **Methods:** Cohort data were obtained from the Gyeonggi Institute of Education for three years (2015–2017), and a total of 16,027 data points were analyzed. We performed a repeated-measures analysis of variance (3 grades × 4 body mass index groups × 5 weekly exercise hours groups) using SPSS software (version 21.0, IBM Corp., Armonk, NY, USA) for data analysis. **Results:** The results obtained through the analysis are as follows. As school grades rose among Korean middle school students, psychological health factors such as mental health, self-concept, self-esteem, and self-efficacy decreased. And the deterioration of psychological health factors showed lower positive results for normal and underweight students than for overweight and obese students. Students with a lot of exercise time every week showed a lower decrease in psychological health factors. **Conclusions:** The results suggest that education for health promotion, considering body mass index and daytime exercise, is necessary to prevent the deterioration of psychological health factors in Korean middle school students.

Keywords: body mass index; weekly exercise hours; middle school students; mental health; self-concept; self-esteem; self-efficacy

1. Introduction

Physical, social, and psychological growth and development are important when Korean middle school students transition from childhood to adolescence. Subsequently, increased food intake following secondary growth, irregular eating habits, decreased physical activity, and various stressors experienced during this period lead to many physical changes [1,2]. Adolescents' rapid physical growth and development, increased interest in appearance, formation of satisfaction criteria, and body image problems may be accompanied by efforts to manage appearance [3,4]. Gaining muscle mass or losing weight may be regarded as regular health-promoting behaviors, mitigating various problems caused by being underweight and obese. However, inappropriate health behaviors owed to lookism can hinder overall health or incur high social costs [5]. Such phenomena typically appear in both Western and Korean societies [1,5–7]. According to an existing study, adolescents' perceptions of obesity and their appearance negatively affect their egos, resulting in inferiority complexes, which adversely affect their school life, such as negatively impacting normal academic relationships [8]. Furthermore,

lower satisfaction with appearance has also been reported to result in grave socio-psychological problems, such as eating disorders, which have deteriorated self-esteem and self-concept [9]. Additionally, students' body dysmorphia (e.g., when experiencing obesity) enhances depression and anxiety symptoms [10]; similarly, strong significant relationships have been observed for (1) same age and stress on school life [11] and (2) low self-efficacy, deteriorated concept of self, and reduced quality of life with feelings of helplessness and suicidal ideation [12,13].

Existing studies have demonstrated the significant positive effect of regular physical activity or exercise on preventing socio-psychological problems and cognitive body image issues in adolescents [14–16]. A longitudinal study of adolescents showed a significant association between physical activity, lower psychological anxiety levels, and greater psychological well-being levels [17]. This is due to the positive effects of regular exercise on physical and psychological health, such as stress relief, better mental health, and improved self-esteem [18,19]. As a result, regular exercise and other healthy lifestyle habits are essential to establishing a foundation of lifelong health for adoles-



cents since increased physical activity has been shown to promote mental and physical health [20–22]. Conversely, reduced physical activity and sedentary behavior adversely influence adolescent obesity, metabolic syndrome, mental disorders (e.g., depression and anxiety), and psychological health, such as subjective well-being and stress [23–29]. Thus, with the constant reduction of physical activity in adolescents, various problems caused by the lack of exercise are on the increase [30]. This is because the privatization of education and social networking channels have considerably restricted physical activity, enhanced usage of smartphones, computer games, and online classes, and increased the stress of school work. Furthermore, a study of adolescents' physical education activities found that as grades increased, the average time spent on physical activity decreased; thus, the physical education activity participation time was increasingly shorter for Korean students in high-, middle-, and elementary school [31]. Approximately 57.3% of adolescents reported not engaging in physical activity for more than 30 minutes during the past week, and 20.9% did not participate in physical activity for more than 30 minutes [32]. Additionally, previous studies show that academic stressors are significant factors for adolescents [33], which are enhanced as grades increase [34]. In addition, adolescent obesity deteriorates self-concept and self-esteem, alongside the development of various metabolic and mental health disorders [9,35]. However, there is a limitation in that previous studies that verified the effects of proper BMI maintenance and regular physical activity, were mainly conducted as cross-sectional studies. This point was emphasized in studies examining the effects of weight-related factors, such as physical activity and obesity (i.e., being overweight), on adolescent psychological health factors, through systematic reviews and meta-analyses [36,37]. Specifically, as a result of analytical reviews of previous studies that verified the effect of physical activity on the mental health of children and adolescents (papers published from November 2010 to 2017), it is noted that physical activity is related to mental health. Unlike previous studies [38], they report that self-esteem cannot claim the effect of physical activity, although they agree with the emphasis on the policy to encourage physical activity, and that more research is needed on the anxiety-reducing effect [36]. In particular, verification of the effects of physical activity on various psychological health-related factors including mental health, requires a longitudinal study, that observes according to changes in time and period, considers various types of physical activity, and individual social/physical circumstances. According to a study examining the relationship between sedentary behavior and mental health in adolescents, screen use (watching TV, computers, Internet, etc.) and obesity (being overweight) that increase physical activity and sedentary behavior are associated with mental health problems [37]. However, since most of the preceding studies used in this study are cross-sectional stud-

ies, they cannot be reviewed and compared to longitudinal studies. Moreover, longitudinal studies are needed given the importance of psychological health factors, for instance consideration of factors such as school-related factors (e.g., academic achievement), weight and shape (e.g., appearance), physical ability, personality, and parental management behaviors. Additionally, adolescent obesity has been reported to reduce self-concept and self-esteem, including various metabolic diseases and mental health [9,35], and regular exercise has been reported to have a positive effect on improving mental health and self-esteem [18,19]. However, since these previous studies are cross-sectional studies, there is a limitation, in that the characteristics of longitudinal changes cannot be known. In particular, in a study that comprehensively reviewed studies prior to 2010 [38], it was reported that physical activity has an effect on self-esteem. However, a study [36] that reviewed a summary of subsequent studies, reported that the effect of physical activity could not be claimed. Therefore, it is necessary to conduct a longitudinal study, examining the effect of adolescents' BMI and exercise time per week on psychological health factors, such as mental health, self-concept, self-esteem, and self-efficacy.

Adolescents' mental health and self-concept are crucial to establish the basis of appropriate growth and development, and to experience social interactions simultaneously, including adaptability to school life [39]. Self-esteem [40] refers to a positive self-evaluation, whereas self-efficacy [41] is understood as self-perception, and both of these concepts are critical for forming a psychological foundation that contributes to adolescent growth and development. For proper growth and development, including adaptation to school life, such psychological health variables require continuous research, including alterations to health-related factors in health behavior-related research fields [1,42–45]. Moreover, considering the differences in adolescents' psychological health according to their BMI and the amount of exercise as per the grade, changes in BMI and amount of exercise are involved in the level of awareness of psychological health factors over time.

Therefore, this study employed cohort data collected by the Gyeonggi Institute of Education over three years (2015–2017), for the Gyeonggi Education Longitudinal Study, from enrolled middle school students. The study primarily aimed to longitudinally analyze the differences in students' BMIs and their psychological health—self-concept, self-esteem, and self-efficacy—owing to their weekly exercise participation time. The analysis results can be used as basic data for devising health education curricula, such as efficient arbitration strategies for improving the psychological health of Korean middle school students.

Table 1. General characteristics of research participants.

Year (grade)	Sex (n)	Height (cm)	Weight (kg)	Body mass index (kg/m ²)
2015 (1st grade)	Male (2806)	163.3 ± 7.7	53.6 ± 11.3	20.0 ± 3.4
	Female (2723)	158.3 ± 5.1	48.5 ± 8.1	19.3 ± 2.8
2016 (2nd grade)	Male (2733)	169.2 ± 6.8	59.5 ± 11.7	20.7 ± 3.5
	Female (2603)	160.0 ± 5.0	50.7 ± 7.9	19.8 ± 2.7
2017 (3rd grade)	Male (2670)	172.1 ± 6.1	62.8 ± 12.0	21.2 ± 3.6
	Female (2492)	160.8 ± 5.0	51.9 ± 8.0	20.1 ± 2.8

Data are expressed as mean ± standard deviation.

2. Method

The study's primary purpose was to longitudinally analyze how their weekly exercise participation time affected students' BMIs and their psychological health (self-concept, self-esteem, and self-efficacy). These results can be used to develop health education programs, such as effective arbitration strategies for improving the psychological well-being of Korean middle school students.

2.1 Data Collection

This study collects and analyzes long-term data on Gyeonggi education policies and students' overall educational activities by tracking sample panels formed in 2012. Cohort studies began then for 1st graders, 1st graders in elementary school, and 4th graders, but since 2015, only the cohort of elementary school was maintained and redesigned to analyze school effects through additional sampling. This study also analyzed a questionnaire that surveyed middle school students from 2015 to 2017. It was conducted in accordance with the guidelines of the Declaration of Helsinki and was approved by the Gyeonggi Institute of Education (report code: 2019-04). Ethical approval was waived, as the Gyeonggi Education Panel Study did not collect any private or identifying information. The Gyeonggi Institute of Education provided cooperation and permission to carry out our research. This study used the follow-up data obtained from Korean middle school students (first to third grade) between 2015 and 2017. Specifically, as of 2015, 45 middle schools in 31 cities and counties in Gyeonggi-do, were subject to random sampling, and the first year of middle school consisted of two classes of students per school as a cohort. Longitudinal data were gathered from the same students for three years (until 2017). Regarding research ethics, we conducted a questionnaire survey at the Gyeonggi Institute of Education after explaining the research content and purpose to the parents, teachers, and students of each school and obtaining their consent. Those who did not complete the survey items sufficiently or honestly were excluded. Overall, 16,027 responses (with 5529/6314, 5336/6314, and 5162/6813 responses in 2015, 2016, and 2017, respectively) were used for the data analysis. Table 1 summarizes the general characteristics of the study participants.

2.2 Survey Items and Measurement Tools

BMI was computed using the BMI formula, incorporating the height and weight data obtained from participants' responses to the questionnaire survey. Participants' BMIs were categorized into four groups, according to the obesity judgment guidelines of the Korea Society for the Study of Obesity [46], namely underweight (BMI <18.5), normal body weight (18.5–23.0), overweight (23.01–25.0), and obese (≥25.01).

We computed weekly exercise time, excluding physical education time at school, using the survey data for the past week's exercise duration. These data were categorized into "no exercise", "<1 h", "1 h to less than 3 h", "3 h to less than 5 h", and "≥5 h".

The questionnaire tool for measuring psychological health (mental health, self-concept, self-esteem, and self-efficacy) was constructed by the Gyeonggi Provincial Office of Education [47], for the study design and item development of the Gyeonggi Education Longitudinal Study. For this purpose, a structured questionnaire was developed through expert consultation, and preliminary research was used with reference to related prior research and the Psychological Scale Handbook [45,48]. This is the result of the random sample survey participants partaking in the study for three years (2015–2017), and obtaining their own answers. The self-concept scale comprised two subscales—social self-concept (five items) and physical self-concept (five items)—while mental health (six items), self-esteem (seven items), and self-efficacy (four items) scales had no subscales. Each item was rated using a Likert-type scale that ranged from totally disagree, 1 (not at all), to totally agree, 5 (very much so).

In addition, each research tool was psychometrically validated for internal consistency and reliability, using exploratory factor analysis and Cronbach's α test, respectively. The results revealed psychometrically sound statistics for each research tool. Specifically, the mental health scale reported a single factor, and the appropriateness of the sample and correlation matrix demonstrated a Kaiser-Meyer-Olkin (KMO) value of 0.836. The results of the spherical assay ($\chi^2 = 51322.296$, $df = 15$, $p < 0.001$), were also statistically significant, and the confirmatory factor analysis was adequate (RMSEA = 0.085, CFI = 0.987, TLI

= 0.966, SRMR = 0.022). The Cronbach's α was 0.867, verifying the scale's validity and reliability.

The self-concept scale comprised two factors—social and physical self-concept—with a KMO value of 0.878. The results of the spherical assay ($\chi^2 = 111142.964$, $df = 45$, $p < 0.001$), were also significant. In addition, the standardized estimated values for the social self-concept (0.780–0.881) and physical self-concept (0.627–0.867) factors were high. Moreover, eigenvalues also demonstrated an index of 1 or higher (social self-concept: 3.760, physical self-concept: 3.434). The cumulative diversification rate was 71.940, and the confirmatory factor analysis was adequate (RMSEA = 0.067, CFI = 0.979, TLI = 0.970, SRMR = 0.042). The Cronbach's α was 0.918 and 0.874 for social and physical self-concept, respectively, and the scale's validity and reliability were verified.

The self-esteem scale reported a single factor, with a KMO value of 0.898 and a significant spherical assay result ($\chi^2 = 74843.405$, $df = 21$, $p < 0.001$), and the confirmatory factor analysis was adequate (RMSEA = 0.058, CFI = 0.991, TLI = 0.985, SRMR = 0.018). The Cronbach's α represented an index of 0.758, thereby validating the scale. Lastly, the self-efficacy scale reported a single factor with a KMO value of 0.779, and a significant spherical assay result ($\chi^2 = 50579.286$, $df = 6$, $p < 0.001$), and the confirmatory factor analysis was adequate (RMSEA = 0.077, CFI = 0.944, TLI = 0.932, SRMR = 0.056). The Cronbach's α represented an index of 0.908, and the scale's validity and reliability were verified.

2.3 Data Analysis

This study statistically analyzed data using SPSS and AMOS software (version 21.0, IBM Corp., Armonk, NY, USA). First, participants' general characteristics were investigated by performing frequency analysis, and each questionnaire was verified for reliability and validity by performing exploratory factor analysis, confirmatory factor analysis, and Cronbach's α test, respectively. Second, socio-demographic characteristics were presented using descriptive statistics of mean and standard deviation. Furthermore, a repeated-measures analysis of variance (ANOVA) was performed to analyze changes in mental health, self-concept, self-esteem, and self-efficacy owing to participants' BMIs and one week of exercise time, owing to the increase in grade (measurement time), using the following design: measurement time (3) \times BMI (4) \times 1 week exercise time (5). Additionally, post-hoc tests were used to analyze the differences in measurement time between each population. Lastly, statistical significance was set at $p < 0.05$.

3. Results

A repeated-measures ANOVA was performed to investigate the changes in mental health, self-concept, self-esteem, self-efficacy, psychological health, and grade (mea-

surement time) owing to BMI and weekly exercise duration among Korean middle school students. Table 2 presents the results of the analyses.

The main effects of both measurement time and BMI, and the interactive effect of measurement time and weekly exercise duration, were found to be statistically significant. Furthermore, the interactive effect between measurement time, BMI, and weekly exercise duration was statistically significant for self-concept (social and physical) and self-esteem. However, no significant interactive effect was reported on mental health and self-efficacy. Post-hoc verification also showed significant differences for measurement time and weekly exercise duration on all psychological health factors; no significant differences were observed in mental health and self-efficacy depending on BMI. However, it was found that there is a difference between the concepts of ego (social and physical) and self-esteem. The specific research results are as follows.

3.1 Changes in Mental Health Owing to BMI and Weekly Exercise Duration

As shown in Table 2, the psychological factor of mental health generally decreased as the grade increased. The interactive effect of measurement time with BMI ($F = 34.147$, $p < 0.001$), and with weekly exercise time ($F = 4.650$, $p < 0.001$), were statistically significant for mental health. This indicates that the differences in mental health, as per the grade, are associated with the BMI and weekly exercise time, and vice versa. However, no statistically significant interactive effect ($F = 1.383$, $p > 0.05$) was found between measurement time, BMI, and weekly exercise duration. In addition, the post-hoc test revealed that mental health was associated with the measurement time, demonstrating deteriorating mental health with the increasing order of grades. The increase in weekly exercise did not result in any significant differences according to BMI.

3.2 Changes in Self-Concept Owing to BMI and Weekly Exercise Time

The analysis results, as shown in Table 2, reveal that the psychological health factor of self-concept (social and physical), generally decreased as the grade increased. Moreover, the interactive effect of measurement time with BMI ($F = 45.560$, $p < 0.001$ / $F = 50.100$, $p < 0.001$, respectively), and with weekly exercise time ($F = 4.508$, $p < 0.001$ / $F = 3.793$, $p < 0.001$, respectively), were found to be statistically significant for both social and physical self-concept. However, the interactive effect of measurement time \times BMI \times weekly exercise duration was only significant for physical self-concept ($F = 1.838$, $p < 0.01$), but not for social self-concept ($F = 1.415$, $p > 0.05$). This is because the difference in measurement time between social and physical self-concept depends on the BMI and weekly exercise duration, or the difference between them. The results also showed that physical self-

Table 2. Analysis of psychological health differences due to BMI and weekly exercise time.

Grade (A)	BMI (B)/1-week exercise time (C)	Mental health	Self-concept		Self-esteem	Self-efficacy	
			Social	Physical			
1st Grade	BMI	Underweight ^a	23.41 ± 5.10	20.87 ± 3.52	16.93 ± 4.34	26.53 ± 4.15	14.02 ± 3.39
		Normal weight ^b	23.06 ± 5.21	20.59 ± 3.64	16.10 ± 4.32	26.35 ± 4.24	13.94 ± 3.64
		Overweight ^c	23.57 ± 5.19	19.87 ± 3.89	14.55 ± 4.36	25.99 ± 4.46	13.59 ± 3.54
		Obese ^d	23.54 ± 5.19	19.67 ± 4.17	14.04 ± 4.38	26.00 ± 4.55	13.62 ± 3.61
	Weekly exercise time	No exercise ^①	22.04 ± 5.36	19.80 ± 4.01	14.68 ± 4.36	25.56 ± 4.34	13.20 ± 3.65
		<1 hour ^②	22.76 ± 5.10	20.34 ± 3.64	15.57 ± 4.07	26.07 ± 4.16	13.78 ± 3.32
		1 ≥ 3 hours ^③	23.85 ± 4.96	20.96 ± 3.36	16.83 ± 4.34	26.68 ± 4.13	14.33 ± 3.48
		3 ≥ 5 hours ^④	24.44 ± 4.87	21.17 ± 3.57	17.78 ± 4.26	27.03 ± 4.10	14.48 ± 3.52
		5+ hours ^⑤	24.56 ± 5.14	21.42 ± 3.56	18.03 ± 4.62	27.50 ± 4.37	14.10 ± 3.89
		Total	23.27 ± 5.16	20.63 ± 3.66	16.21 ± 4.41	26.38 ± 4.24	13.93 ± 3.53
2nd Grade	BMI	Underweight ^a	22.95 ± 5.23	20.79 ± 3.56	17.22 ± 4.36	26.49 ± 4.15	13.93 ± 3.44
		Normal weight ^b	22.47 ± 5.34	20.58 ± 3.69	16.50 ± 4.56	26.34 ± 4.37	13.97 ± 3.64
		Overweight ^c	22.71 ± 5.24	20.04 ± 3.67	15.48 ± 4.23	26.17 ± 4.45	13.81 ± 3.44
		Obese ^d	22.90 ± 5.41	19.65 ± 4.21	14.82 ± 4.59	26.07 ± 4.60	13.65 ± 3.61
	Weekly exercise time	No exercise ^①	21.41 ± 5.40	19.81 ± 3.80	15.04 ± 4.43	25.41 ± 4.31	13.21 ± 3.61
		<1 hour ^②	22.35 ± 5.19	20.40 ± 3.61	15.96 ± 4.20	26.23 ± 4.11	13.92 ± 3.41
		1 ≥ 3 hours ^③	23.40 ± 5.09	20.92 ± 3.60	17.47 ± 4.35	26.91 ± 4.23	14.33 ± 3.53
		3 ≥ 5 hours ^④	23.98 ± 5.04	20.94 ± 3.64	17.95 ± 4.54	26.80 ± 4.33	14.18 ± 3.53
		5+ hours ^⑤	24.45 ± 5.29	21.58 ± 2.75	18.82 ± 4.74	27.57 ± 4.91	14.51 ± 3.83
		Total	22.68 ± 5.30	20.52 ± 3.71	16.50 ± 4.53	26.35 ± 4.33	13.92 ± 3.56
3rd Grade	BMI	Underweight ^a	22.39 ± 5.33	20.39 ± 3.83	16.92 ± 4.50	25.89 ± 4.25	13.72 ± 3.51
		Normal weight ^b	22.20 ± 5.44	20.32 ± 3.84	16.66 ± 4.44	26.13 ± 4.39	13.67 ± 3.65
		Overweight ^c	22.57 ± 5.37	19.87 ± 3.86	15.82 ± 4.26	25.82 ± 4.31	13.72 ± 3.43
		Obese ^d	22.14 ± 5.66	19.51 ± 4.12	15.12 ± 4.72	25.85 ± 4.73	13.65 ± 3.73
	Weekly exercise time	No exercise ^①	21.17 ± 5.54	19.31 ± 4.16	15.01 ± 4.50	25.04 ± 4.57	13.14 ± 3.64
		<1 hour ^②	22.12 ± 5.32	20.20 ± 3.64	16.12 ± 4.18	25.92 ± 4.17	13.71 ± 3.38
		1 ≥ 3 hours ^③	22.92 ± 5.17	20.71 ± 3.71	17.41 ± 4.39	26.51 ± 4.16	13.95 ± 3.58
		3 ≥ 5 hours ^④	23.35 ± 5.28	21.05 ± 3.51	17.95 ± 4.30	26.75 ± 4.14	14.59 ± 3.53
		5+ hours ^⑤	23.23 ± 5.83	20.68 ± 4.14	18.21 ± 4.61	26.62 ± 5.00	13.62 ± 4.12
		Total	22.28 ± 5.43	20.22 ± 3.88	16.50 ± 4.50	26.00 ± 4.38	13.69 ± 3.60
A × B		43.167***	45.560***	50.100***	46.290***	45.055***	
Interaction A × C		4.650***	4.508***	3.793***	4.291***	4.620***	
A × B × C		1.383	1.415	1.838**	1.541*	1.514	
Grade		1>2>3	1>2>3	2,3>1	1,2>3	1,2>3	
Post-hoc BMI		-	a,b,>c,d	a>b>c>d	a,b>c,d	-	
Weekly exercise time		⑤>④,③,②>①	⑤,④>③>②>①	⑤,④>③>②>①	⑤>④,③>②>①	④,③>⑤,②>①	

Data are expressed as mean ± standard deviation, BMI, body mass index; A: Grade, B: BMI, C: Weekly exercise time; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; tested by repeated measures analysis of variance, underweight: <18.5 BMI, normal weight: 18.5–23.0 BMI, overweight: 23.01–25.0 BMI, obese: >25.0 BMI.

concept can vary depending on the measurement time and the difference between BMI and weekly exercise time. Additionally, the post-hoc test revealed that the social self-concept demonstrated a decreasing trend, as per the measurement time in the order of the first, second, and third grades. However, physical self-concept was found to be lower in the first grade than in the second and third grades. Social self-concept was also higher in the underweight and normal-weight BMI groups compared with the overweight and obese BMI groups, whereas physical self-concept was higher in the order of underweight, normal weight, overweight, and obese BMI groups. Lastly, both social and

physical self-concept was highest for participants who exercised for “5 hours or more”, followed by those who exercised weekly for “less than 5 hours”, “less than 3 hours”, “less than 1 hour”, and those who did “no exercise”.

3.3 Changes in Self-Esteem Owing to BMI and Weekly Exercise Duration

As shown in Table 2, the psychological health factor of self-esteem generally decreased as the grade increased. The interactive effect of measurement time with BMI ($F = 46.290$, $p < 0.001$), and weekly exercise duration ($F = 4.291$, $p < 0.001$), were statistically significant for self-

esteem. Furthermore, the interactive effect of measurement time \times BMI \times exercise time per week, was also statistically significant for self-esteem ($F = 1.541, p < 0.05$). This is because the difference in the measurement time of self-esteem may depend on the BMI and weekly exercise time, and vice versa. It can also be changed by the difference between the measurement time, BMI, and weekly exercise duration. Additionally, the post-hoc test revealed that self-esteem, depending on the measurement time, was not significantly different between the first and second grades but decreased in the third grade. Self-esteem was higher in the underweight and normal-weight BMI groups compared with those in the overweight and obese BMI groups. Lastly, depending on the weekly exercise duration, participants reported the highest self-esteem when they exercised weekly for “5 hours or more”, followed by those who exercised weekly for “less than 5 hours”, “less than 3 hours”, “less than 1 h” and those who did “no exercise.”

3.4 Changes in Self-Efficacy Owing to BMI and Weekly Exercise Duration

As shown in Table 2, the psychological health factor of self-efficacy generally decreased as students' grades increased. The interactive effect of measurement time with BMI ($F = 45.055, p < 0.001$), and weekly exercise duration ($F = 4.620, p < 0.001$), were statistically significant for self-efficacy. This indicates that, depending on the BMI and weekly exercise duration, the difference in the self-efficacy owing to measurement time may vary and vice versa. However, the interactive effect ($F = 1.514, p > 0.05$) of measurement time \times BMI \times weekly exercise duration, was not significant for self-efficacy. Additionally, the post-hoc test revealed no difference in self-efficacy based on the measurement time between the first and second grades, but it decreased in the third grade.

4. Discussion

This study used cohort student data collected by the Gyeonggi Institute of Education over three years (2015–2017), for the Gyeonggi Education Longitudinal Study, from Korean middle schools. The current study primarily aimed to longitudinally analyze the differences between students' BMIs and their psychological health variables of mental health, self-concept, self-esteem, and self-efficacy, owing to weekly exercise time. The research findings are comprehensively discussed below.

With increasing school grades, mental health, self-concept, self-esteem, and self-efficacy decreased. However, it was shown that the interactive effect between the measurement time and BMI and the measurement time and the exercise time for one week were both significant, and the degree of decrease was found to be different depending on the BMI and weekly exercise duration. These results suggest that Korean middle school students' psychological health (mental health, self-concept, self-esteem, and self-

efficacy) tended to decrease as they progressed to the next grade. These findings suggest a difference in the degree of decrease depending on students' BMIs and their weekly exercise duration. This result is because Korean middle school students become more interested in appearance during puberty and experience dissatisfaction with their body weight and shape [49,50]. This may be owing to an increase in the stress generated in school and academic life, such as excessive use of smartphones due to social networks and computer games [49,50], and restricted physical activity due to increasing cut-offs for university entrance policies, which limits personal physical education time [31]. Approximately 57.3% of Korean adolescents lack physical activity [32]. In addition, adolescents' stress is majorly aggravated by academic factors [33], and studies that report further aggravation of stress with increased school grades are indirectly supported [34]. Based on existing literature and field experience, it can be assumed that the higher the grade, the higher the schools' and parents' demands for students' various academic performance efforts to prepare for the entrance exam will be.

Previous studies have reported that adolescents' BMI influences psychological health factors, such as adaptability to school life, stress, quality of life, mental health, self-concept, self-esteem, and self-efficacy [1,6–13]. Particularly, existing findings reported that students who were overweight and obese demonstrated lower self-esteem, self-concept, and self-efficacy. These findings are consistent with the current study results that psychological health factors are impacted by an interactive effect between measurement time and BMI, and their interaction may change over time. Additionally, students who were underweight and normal weight reported higher social and physical self-concept and self-esteem than those who were overweight and obese. These results were considered to be owing to lookism, which leads to a preference for lean and muscular body shapes. This conclusion is indirectly supported by another study [50,51] among Korean middle school students, where male and female students preferred normal and low weight as their ideal body. Thus, it is believed that adolescents' misconceptions regarding ideal body shapes promote inappropriate appearance management behaviors and adversely affect their health. Therefore, it is necessary to provide more detailed health education curricula, considering the fact that the effect of BMI and measurement time on psychological health factors varies as Korean middle school students progress through the grades.

Previous studies have consistently reported that regular exercise participation positively affects psychological health factors, such as adolescent stress relief, mental health, and self-esteem [14–17,21,22]. It can be concluded that the results of this study are consistent with those shown in previous studies. Specifically, although Korean middle school students' psychological health factors tended to decrease as grades increased, the degree of this decrease

slowed as weekly exercise duration increased. This is because regular exercise participation and increased physical activity positively improve physical and mental health, provide stress relief, and enhance self-esteem [18,19,21,22]. Therefore, government-level systems, such as school sports clubs and health education for regular and sustainable physical activities by students themselves, should be actively developed and implemented at school sites.

Conversely, a significant interactive effect was found between the measurement time, BMI, and weekly exercise duration, for the psychological health factors of physical self-concept and sense of self-esteem. This result is because the psychological health factors of physical self-concept and self-esteem are more crucial to BMI and weekly exercise time than mental health, social self-concept, and self-efficacy, especially as the grade increases. These findings also represent Korean middle school students' interest in being focused on their appearance during this period, which is greatly related to their physical self-concept and sense of self-esteem, and determined by their perception of their appearance and physical ability. Thus, these students demonstrate remarkable appearance management behaviors when criteria for satisfaction and dissatisfaction with body shape and weight are evaluated [3,4]. We believe that physical self-concept [52] and self-esteem [39] tend to exhibit BMI, weekly exercise duration, and characteristics that change with increasing grades during this period. Therefore, to prevent the deterioration in these students' physical self-concept and self-esteem, it is necessary to actively and holistically implement health education to promote the importance of appropriate body shape preferences and regular physical activity.

5. Conclusions

This study used student cohort data collected by the Gyeonggi Institute of Education over three years (2015–2017), for the Gyeonggi Education Longitudinal Study, from Korean middle schools. Specifically, this study primarily aimed to longitudinally analyze the differences between students' BMI and their psychological health (mental health, self-concept, self-esteem, and self-efficacy), owing to weekly exercise time.

The following conclusions were drawn from the data analysis findings: Korean middle school students' psychological health factors of mental health, self-concept, self-esteem, and self-efficacy tended to decrease as their grades increased. However, lower degrees of deterioration in psychological health factors were observed in students who were normal-weight and underweight and those performing weekly exercise for a longer duration, compared with those who were overweight and obese. Previous studies examining the effects of adolescents' BMIs and physical activity on their psychological health were mostly cross-sectional studies using data collected at a single time point. This study was reviewed through a longitudinal study us-

ing cohort survey data for three years, and the data used for the final analysis comprised 16,027 copies of big data, so the results thereof have practical implications. Therefore, it is necessary to consider the current results and ensure efforts to develop and implement a comprehensive health education program that can prevent and arbitrate the decrease in psychological health factors among Korean middle school students. Considering the decreasing trend of psychological health factors with the increase in grade, various exercise participation programs, such as appropriate body shape preferences, proper weight maintenance behaviors, and school sports club activities, must be implemented from the beginning of Korean middle school. Furthermore, regular exercise habits should be promoted by developing and disseminating such interventions to maintain or increase the amount of exercise among students. However, in this study, BMI and weekly exercise duration, maintained from grades 1 to 3, were not tracked and observed in the long term, and individual exercise time per week was not measured and analyzed from a quantitative MET perspective through IPAQ.

The tools for measuring psychological health factors (mental health, self-concept, self-esteem, and self-efficacy) used in this study were constructed during the study design for the Gyeonggi-do longitudinal study by the Gyeonggi Provincial Office of Education [47]. The Gyeonggi Provincial Office of Education conducted the first review of previous research papers for the research design and item development of the Gyeonggi Longitudinal Study of Education. Specifically, the items of various longitudinal studies that have already been conducted, such as the longitudinal studies of Korean, and Seoul education, the youth panel, and the education and employment panel, were referenced. Second, an expert council was held for domestic and foreign experts to receive advice and review the latest research trends, longitudinal study designs and implementation processes. Third, in order to review the validity and suitability of the survey tool, an intensive discussion was conducted on the development thereof. The focus group interview method was used to collect and reflect opinions on the validity, meaning, and necessity of each question, centered on field teachers. Fourth, a preliminary survey was conducted to confirm the validity and reliability of the survey tool produced through the above process. Based on the results of a preliminary survey conducted among 300 elementary, middle, and high school students, the questions for the main survey were formulated based on the validity of the survey tool and appropriateness of expression. Through the above process, the Gyeonggi Provincial Office of Education has sufficiently secured the validity and reliability of the survey tool.

Author Contributions

Design—E-SK, HA, MS, and Y-HS; study conduction—E-SK, HA, MS, and Y-HS; data collection—

E-SK, HA, MS, and Y-HS; data analysis—E-SK, HA, MS, and Y-HS; data interpretation—E-SK, HA, MS, and Y-HS; writing - original draft preparation—E-SK, HA, MS, and Y-HS; writing - review and editing—E-SK, HA, MS, and Y-HS. All authors have read and agreed to the published version of the manuscript.

Ethics Approval and Consent to Participate

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Gyeonggi Institute of Education (report code: 2019-04). Gyeonggi Education Panel Study did not collect private information, ethical approval was not required for this study.

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Conflict of Interest

The authors declare no conflict of interest.

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