

Longitudinal Effects of Body Mass Index and Self-Esteem on Adjustment From Early to Late Adolescence: A Latent Growth Model

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ABSTRACT

Background: Mental and physical development during adolescence is a factor that may affect quality of life in adulthood.

Purpose: The aims of this study were to investigate the developmental trajectories of body mass index (BMI), self-esteem, and adjustment among students from early to late adolescence and to examine the longitudinal relationships among these variables.

Methods: Data from 2006 to 2012 were collected from the Korean Welfare Panel Study. Of the initial sample of 521 students, 487 completed a validated questionnaire measuring BMI, self-esteem, and adjustment. Latent growth curve modeling analyses were conducted to examine the relationships among the variables.

Results: Univariate linear growth models showed a significant increase in BMI and significant declines in both self-esteem and adjustment across three time points from childhood to adolescence. The goodness of fit of the multivariate conditioned model supported the validity of the proposed longitudinal model (comparative fit index = .93, root mean square error of approximation = .08). Change in BMI was significantly linked with change in adjustment ($\beta = .18, p < .05$) but not with change in self-esteem, whereas change in self-esteem exerted a statistically significant effect on change in adjustment ($\beta = .47, p < .001$).

Conclusions/Implications for Practice: Our findings indicate that BMI and self-esteem are key determinants of student adjustment in school settings. Therefore, future health education interventions should focus on enhancing the positive physical and mental self-concepts of students, which should improve health and social behavior among students and subsequently afford a better quality of life for these students in adulthood.

KEY WORDS:

BMI, self-esteem, adjustment, adolescence.

adjust well to school, some have difficulties and experience instability in school life. If the prevalence of mental and physical problems continues to rise, especially at younger ages, the negative effects on health and quality of life in adulthood may worsen. The effects of various factors contributing to physical dissatisfaction are known to begin before puberty, and early adolescence is when the expression of psychiatric problem behavior typically begins (Shin & Shin, 2008). It is thus important to understand the dynamics of students' developmental patterns, identify the protective factors that are amenable to intervention, and control the school context to ease the difficulties of the early stages of life and thus ensure better adjustment in adulthood.

Students experience better adjustment to school when they perceive that their basic psychological needs are being satisfied. This in turn helps individuals integrate and actualize themselves and regulate their behavior and emotions (Deci & Vansteekiste, 2004) and results in benefits such as physical and psychological well-being, effective coping, and a high quality of life (Ratelle & Duchesne, 2014; Shoshani & Slone, 2013). Students perceive themselves from both physical and psychological perspectives. From the physical perspective, students tend to compare themselves with their friends and to establish a body image based on these comparisons. Body mass index (BMI) is closely related to body image (Chyung, 2010; Kostanski, Fisher, & Gullone, 2004). Body weight, a determinant of BMI, is an important criterion that affects student satisfaction with physical status and is associated with various

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Introduction

Students acquire knowledge and develop skills across their years in school and must face and adjust to various demands and challenges as they mature. Although most students

dimensions of adjustment (Heshmat et al., 2015). Moreover, satisfaction with appearance increases self-esteem in adolescence and positively affects the self (Riesch, Anderson, & Krueger, 2006; Shin & Shin, 2008).

Self-esteem is a positive feeling about the self that is widely assumed to be an important determinant of healthy development in adolescence. Self-esteem in youth is culturally sensitive and maintained within consensual social contexts (Y. Wang & Ollendick, 2001). This feeling is known to develop gradually and to change with maturity. In early adolescence, for example, self-esteem may be partially determined by prenatal and early-life environments and experiences. Low levels of self-esteem in adolescence may negatively influence the longer-term course of development into adulthood (Trzesniewski et al., 2006). Self-esteem is thus an important determinant of the physical and mental health of adolescents that affects all aspects of human development.

Previous studies have found an association between being overweight, a low level of self-confidence in appearance, and dissatisfaction with body size, with low levels of competence in terms of global self-worth and appearance (Hesketh, Wake, & Waters, 2004; Sung, Yu, So, Lam, & Hau, 2005). Differences in self-esteem between overweight and normal-weight adolescents and the relationships between them have also been examined, and overweight status was associated with poor body perception and poor body perception with poor self-worth (Chen, Yeh, & Kennedy, 2007) and quality of life (Aldaqaal & Sehlo, 2013). A high level of self-esteem has been shown to improve psychological adjustment and health-related behavior. Several studies have reported a close relationship between self-esteem and adjustment, with this relationship found to have a lifelong impact (National Youth Policy Institute, Korea, 2006). Adolescents' perceptions of themselves, how they cope, and what strategies they use are important factors affecting their physical and mental health.

Adolescent obesity is a global epidemic associated with rapid economic growth. According to a youth nutrition and healthy behavior survey that was conducted by the Korean Centers for Disease Control and Prevention (2012), the prevalence of childhood obesity nearly doubled between 2007 and 2012, rising from 7.6% to 14.1%. Obesity in childhood and adolescence is thus an issue of growing social concern in Korea (Lim, Xue, & Wang, 2014). Furthermore, the rising prevalence of Westernized lifestyles under conditions of economic growth has been associated with many other health problems in children and adolescents (Shin & Shin, 2008). Research around the world has found that gender affects the prevalence of obesity (Avsar, Ham, & Tannous, 2017; Badr, Lakha, & Pennefather, 2017; Sweeting, 2008; Y. Wang & Beydoun, 2007). This is the case in Korea as well, where obesity rates in male and female students differ significantly (Ministry of Health and Welfare, Korea Centers for Disease Control and Prevention, 2014). A national survey on obesity among adolescents conducted in Korea shows that the

obesity rate for male students is higher than for female students and that this rate rises as students advance through school (Ministry of Health and Welfare, Korea Centers for Disease Control and Prevention, 2014). However, obese female students feel relatively more depressed and have lower self-esteem than their male counterparts. In addition, research on obese adolescent students showed that female students have lower self-esteem than male students when they entered middle and high schools, although no gender gap in levels of self-esteem was identified among students in elementary school (Jeong, Kahng, & Kim, 2014).

Although the relationship among BMI, self-esteem, and adjustment has been examined in previous research, little is known about the longitudinal relationship among these variables in Korean adolescents. Longitudinal evaluation of the various influences on adolescent adjustment from the physical and psychological perspectives may facilitate the development of strategies to achieve better health outcomes. This study was conducted to determine how patterns of BMI and self-esteem predict the adjustment of students from early through late adolescence.

Methods

Study Design and Sample

This study was a secondary analysis of data from the Korean Welfare Panel Study (KOWEPS), an annual longitudinal panel survey of a nationally representative sample of South Korean households. The first KOWEPS occurred in 2006, and the most recent study was conducted by the Korea Institute for Health and Social Affairs and Seoul National University Social Welfare Research Center. Proportional, systematic, stratified cluster sampling was used to select a representative sample of households. The survey questionnaire was composed of a household and household member survey. This study used data from the 2006 (Wave 1), 2009 (Wave 4), and 2012 (Wave 7) surveys, which included a supplementary adolescent survey that targeted students over time.

The participants in the first KOWEPS wave were elementary school students in Grades 4–6, whereas those in the fourth and seventh waves were middle and high school students, respectively. The samples in Waves 1, 4, and 7 included 759 individuals from 7,072 households, 609 individuals from 6,207 households, and 521 individuals from 7,532 households, respectively. From these observations, we excluded 48 individuals with incomplete information on some of the variables. Hence, 473 individuals from Wave 1 were used in the final data analysis. The sample consisted of 242 male students (51.2%) and 231 female students (48.8%). The sample was fairly, evenly divided among students in the fourth (32.3%), fifth (33.2%), and sixth (34.5%) grades and was economically diverse, with 30.4% from low-income families and 69.6% from middle-income families. The study followed Declaration of Helsinki ethical principles. Because the study data are publicly

available (<http://www.koweps.re.kr/>) and all individual information is anonymized, no ethical approval was needed.

Measurements

Self-esteem was measured using the 10-item Rosenberg Self-Esteem Scale (Rosenberg, 1965). Each item is scored on a 4-point Likert scale, giving a scale range of 10–40, with higher scores indicating higher self-esteem. In this study, the Cronbach's alpha was .87.

Adjustment was measured using nine items developed by KOWEPS and validated in a previous Korean study (Jung & Chung, 2011). Sample items include "I have been feeling good at school," "I have been keeping up to date with my academic subjects," and "I have friendly relationships with people at school." Respondents are asked to indicate the extent to which each item applies to them using a 4-point Likert scale ranging from 1 = *not at all* to 4 = *very well*, with a higher score indicating a higher level of psychological adjustment to school life. In this study, the Cronbach's alpha was .77.

BMI (kilograms per square meter) was calculated using participants' height and weight. We used raw BMI instead of a BMI *z* score. Because BMI *z* scores indicate a child's position relative to his or her peers, raw BMI data are recommended for use in longitudinal analyses (Berkey & Colditz, 2007; Cole, Faith, Pietrobelli, & Heo, 2005).

Gender was controlled in this study and measured using a dummy-coded variable because weight gain trends differ according to gender during adolescence.

Statistical Analyses

Latent growth curve modeling was performed to test the relationships among the variables longitudinally. Latent growth modeling is a growth curve analysis that is based on structural equation modeling. This approach models individual trajectories of change, allowing the correlation of patterns of change among multiple outcome measures across multiple time points to be identified simultaneously (Stull, 2008).

This study developed and tested a univariate latent growth model by comparing two models: a no-growth model and a linear-growth model. The model fit indices of the two models were compared to determine which better described changes

over time. The intercept and slope of each model were then tested. After confirming the statistical significance of the intercept, slope, and model fit of the two base models, an integrated model was developed and examined. To reduce the possibility of biased estimates, full information maximum likelihood estimation was conducted. Analyses were performed using IBM SPSS Amos 23.0 (IBM, Armonk, NY, USA). Because the chi-square statistic is too sensitive for the sample size, we used three model fit indices to estimate the proposed model: the comparative fit index ($CFI > .90$), the normed fit index ($> .90$), and the root mean square error of approximation ($RMSEA < .08$). The full information maximum likelihood method for handling missing data was used.

Results

Descriptive Statistics

The mean BMI scores were 19.11 ($SD = 3.91$) in Wave 1, 20.09 ($SD = 3.25$) in Wave 4, and 21.31 ($SD = 3.29$) in Wave 7. From Waves 1 to 7, the mean self-esteem scores were 25.61, 25.31, and 24.94, respectively. The mean levels of adjustment were 20.18, 19.85, and 19.31, respectively (see Table 1).

Test of Univariate Model

On the basis of the univariate model analysis, the slope was assumed to have linear growth, as the loading slope factors were fixed at values of 0, 1, and 2 in the base models. Table 2 presents the observed variables in each base model, along with the model fit statistics. The model fit of each was satisfactory overall, and it was determined that the slope factors for the three constructs estimated linear changes. The univariate linear growth models show that BMI had an initial score of 19.09 ($p < .001$), with an increase of 8.38 ($p < .001$). Self-esteem and adjustment presented initial scores of 25.99 ($p < .001$) and 20.21 ($p < .001$), respectively, with declines of 0.39 ($p < .001$) and 0.44 ($p < .001$). The *SDs* of intercept and slope were statistically significant in both base models.

TABLE 1.
Descriptive Statistics for the Three Survey Waves (N = 473)

Time of Assessment	BMI		Self-Esteem		School Adjustment	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Wave 1 (2006)	19.11	3.91	25.61	5.76	20.18	3.65
Wave 4 (2009)	20.09	3.25	25.31	6.42	19.85	3.37
Wave 7 (2012)	21.31	3.29	24.94	6.07	19.31	3.41

Note. BMI = body mass index.

TABLE 2.
Results of Univariate Growth Model Analyses

Model	Intercept		Slope		χ^2	df	p	CFI	RMSEA
	M	SD	M	SD					
BMI	19.09***	1.09***	8.38***	1.26***	2.75	2	.252	.998	.034
Self-esteem	25.99***	20.08***	-0.39**	10.51***	16.99	2	< .001	.852	.054
Adjustment	20.21***	5.46***	-0.44***	1.66***	2.44	2	.296	.995	.021

Note. BMI = body mass index; CFI = comparative fit index; RMSEA = root mean square error of approximation.

** $p < .01$. *** $p < .001$.

Goodness of Fit of the Multivariate Latent Growth Model

We examined the associations between changes over time in BMI, self-esteem, and adjustment. The model fit indices of the integrated multivariate latent growth model revealing good data adjustment with acceptable indices: $\chi^2 = 152.57$ ($df = 21$), $p < .001$, CFI = .93, normed fit index = .93, incremental fit index = .92, Tucker–Lewis index = .85, and RMSEA = .08.

The final model indicates that BMI_Intercept exerts effects on both Self-Esteem_Intercept ($\beta = -.19$, $p < .05$) and Adjustment_Intercept ($\beta = -.10$, $p < .05$). However, BMI_Intercept had no statistically significant effect on either Self Esteem_Slope or Adjustment_Slope. BMI_Slope exerted an effect on Adjustment_Slope ($\beta = .19$, $p < .05$) but not on Self-Esteem_Slope. Finally, Self-Esteem_Intercept exerted effects on both Adjustment_Intercept ($\beta = .53$, $p < .001$) and Adjustment_Slope ($\beta = -.08$, $p < .01$), and Self-Esteem_Slope had a statistically significant effect on Adjustment_Slope ($\beta = .47$, $p < .001$). The influence of gender on Adjustment_Slope was not significant. These results are presented in Figure 1.

Discussion

This study was conducted to analyze longitudinal changes in the factors affecting children's adjustment from the physical and psychological perspectives and to verify the relationship among linear changes in those factors. We first performed unconditioned univariate growth modeling to measure changes in BMI, self-esteem, and adjustment at the individual level across three time points from early to late adolescence. We included latent variables corresponding to the growth parameters within each univariate growth model. All three models presented statistically significant values for the estimated means, indicating that the parameters were significantly different from zero. They also presented significant values for the estimated variances, indicating significant heterogeneity in the changes over time. Participants' BMI trajectories tended to start higher and change faster between the surveys at Wave 4 (middle school) and Wave 7 (high school), suggesting that teenagers between the ages of 13 and

15 years undergo the most intense physical changes. This is consistent with previous studies (Peterson & Fox, 2007; Sabo, Lu, Daniels, & Sun, 2012). A significantly negative covariance coefficient was obtained for BMI, which suggests that participants with lower initial BMI values displayed a higher rate of change over the three survey waves. However, further research is needed to determine the biological and environmental factors influencing changes in BMI over time.

Self-esteem and adjustment levels exhibited slower declines over time as participants grew older, although adjustment declined more rapidly than self-esteem. A greater decline was observed in the period between middle and high school than in the period between elementary and middle school. These results indicate that teenagers have lower self-esteem and more psychological adjustment difficulties than children of elementary school age. In Korea, teenagers worry about their grades and appearance, a situation that is largely unchanged from 2002 (Korean Statistical Information Service, 2014). Interest and satisfaction with the appearance of youth in Korea may be compared with those in foreign countries. Attention to appearance is high in Korea, but appearance satisfaction is low. Psychological difficulties related to appearance distress may lead to maladjustment to school life (National Youth Policy Institute, Korea, 2006). There is a further need to examine the longitudinal influences that are associated with the developmental process to promote better physical and mental health in adolescents. The standard deviations of the slopes for all variables were statistically significant. It may thus be deduced that the developmental trajectories of the variables are heteronymous, with the participating students exhibiting different developmental patterns. This finding is consistent with previous related research, which found no uniform patterns of perceived school adjustment trajectories from early to late adolescence (Ratelle & Duchesne, 2014).

We examined overall fit measures. Because χ^2 is more likely to be influenced by sample size, this value is often used to identify significant discrepancies between the proposed model and the observed data (Kline, 2005). We considered the hypothetical latent growth model according to the CFI and RMSEA. The CFI is classified as a measure of incremental fit that compares a proposed model with a null model (Hair, Anderson, Tatham, & Black, 1998). The

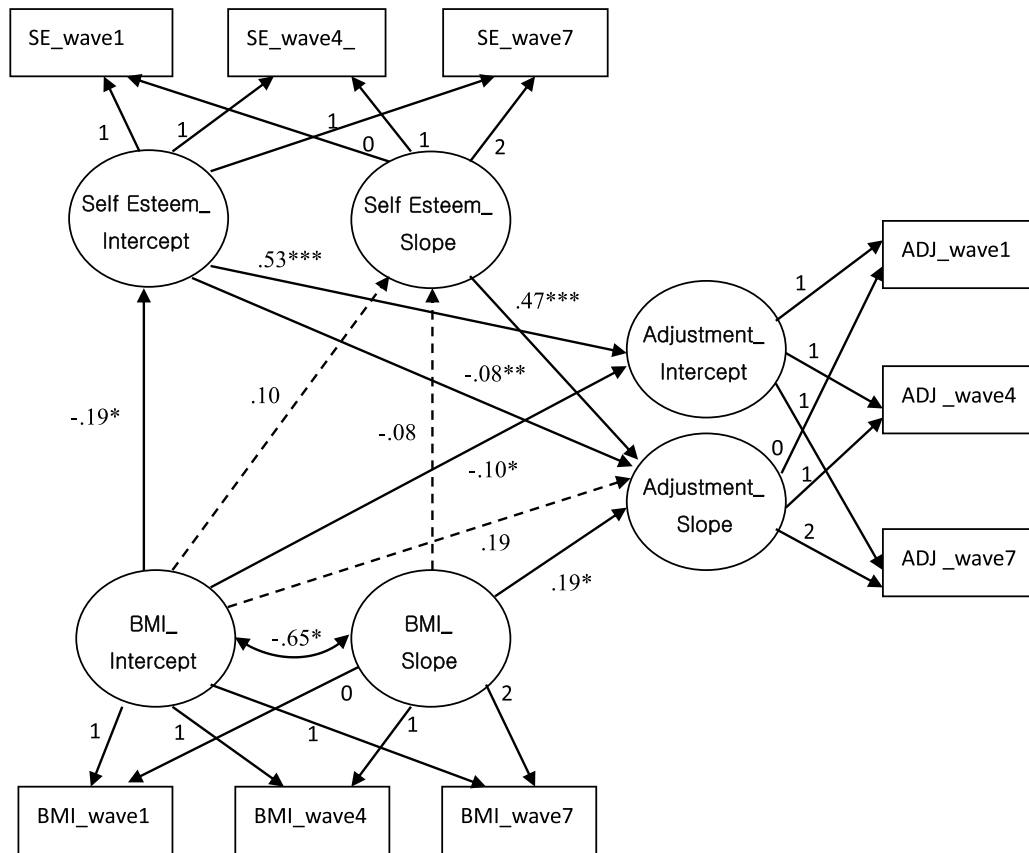


Figure 1. Multivariate latent growth model. * $p < .05$. ** $p < .01$. *** $p < .001$.

multivariate latent model revealed acceptable fit indices. Analysis of the multivariate latent model showed that BMI affected both self-esteem and adjustment. More specifically, children with higher initial levels of BMI had poorer self-esteem and were less psychologically adjusted to the school environment. BMI_Intercept exerted a statistically significant effect on Self-Esteem_Intercept but not on Self-Esteem_Slope. These results are consistent with cross-sectional studies showing BMI to be inversely associated with self-esteem in children (Franklin, Denyer, Steinbeck, Caterson, & Hill, 2006; Shin & Shin, 2008). Self-esteem is a multidimensional construct that is influenced by a variety of factors. In this study, the first survey wave was conducted when participants were between the ages of 10 and 12 years, an age at which weight may influence body image self-perception, which is known to affect self-esteem. However, as children enter middle school and then high school, a change in body weight may no longer trigger a change in self-esteem. We found no statistically significant association between BMI_Intercept and Self-Esteem_Slope, which is inconsistent with longitudinal studies showing excess body weight to precede the development of low self-esteem (Hesketh et al., 2004; Strauss, 2000) but consistent with a study of adolescents in Hong Kong (H. Wang, Leung, & Schooling, 2015). This discrepancy may be the result of measurement inconsistencies, different participant age ranges, and vari-

ous differences in the socioeconomic environmental factors considered. However, a poor self-image related to body weight may be a risk factor for the development of poor self-esteem in overweight or underweight children and adolescents, which is an issue that requires further study.

The intercept and slope of self-esteem exerted significant effects on Adjustment_Intercept and Adjustment_Slope, respectively, in this study, thus supporting the view that the development of healthy self-esteem positively affects the school life of adolescents. It is known that high levels of self-esteem promote emotional well-being and stability (Harter, 1993). Previous studies on self-esteem in childhood and adolescence indicate that the moderating influence of youth characteristics, environmental experiences, and processes in the formation and maintenance of self-esteem should be considered (Dubois & Tevendale, 1999). In addition, these studies have pointed out that the bidirectional, recursive link between self-esteem and adjustment requires serious study. Therefore, interventions to reinforce self-esteem must be considered to promote better adjustment to school life in adolescents.

Although this study contributes to the analysis of the trajectories of and relationships among various physical and psychological variables from early to late adolescence in Korea, it was potentially affected by several limitations. First, we tested whether changes in BMI and self-esteem predict changes in students' adjustment. Analyses revealed

that changes in adjustment were explained by changes in BMI and self-esteem. However, as students enter middle and high school, the influence of other factors such as academic pressure and interpersonal relationships may become more pronounced. In addition, during early adolescence, students may be more influenced by their parents, even in peer-dominant environments. Hence, additional variables likely to exert effects on adolescent adjustment must be integrated and examined. Moreover, differentiating trajectories among obese, overweight, and normal-weight persons should be examined. Second, because of the small sample of panel survey data available, we analyzed the characteristics of the participants as a whole rather than separately. In addition, as this study used previously collected data, the findings do not reflect all of the variables related to juvenile obesity. Thus, future studies should consider multilevel integration.

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