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RESEARCH ARTICLE **OPEN ACCESS**

Predictors of Adolescents' Subjective Happiness Based on Roy's Adaptation Model: A Longitudinal Study

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Abstract:

Introduction/Objective: Improving subjective happiness is significant since it is a measure of positive development and has been linked to health benefits during adolescence. The purpose of this study was to investigate factors associated with longitudinal changes in subjective happiness among Korean adolescents based on Roy's adaptation theory.

Methods: This secondary data analysis study used longitudinal data from 2018 and 2021 from the Korea Welfare Panel Study. This study examines the major stimuli and environmental factors influencing adolescents, categorized as focal and contextual stimuli. Cognitive and emotional strategies, conceptualized as the cognator, are measured through depression, anxiety, withdrawal, and aggression. External adaptive responses, including self-concept and role function, are evaluated for their effects on subjective happiness. To identify the factors associated with subjective happiness, hierarchical multiple linear regression was conducted, with focal stimuli and contextual stimuli included in the first step, cognator in the second, and self-concept and role function in the third, respectively.

Results: The mean age of 324 adolescents was 13.94 (SD±0.80) years, and the subjective happiness scores were 25.10 (SD±4.00) and 19.56 (SD±3.49) at baseline and after three years, respectively. Neglect in focal stimuli (β =-0.11, 95% CI: -0.96, -0.02), academic environment in contextual stimuli (β =0.15, 95% CI: 0.04, 0.39), depression & anxiety in cognator (β =-0.20, 95% CI: -0.29, -0.04), and peer attachments (β =0.19, 95% CI: 0.11, 0.45) in role function explained 14.5% of the variance in subjective happiness.

Conclusion: After a 3-year longitudinal observation, adolescents' subjective happiness decreased, with neglect and academic environment as key stimuli, depression and anxiety as cognitive responses, and peer attachments as role functions. These results emphasized the need for interventions to enhance emotional support, prevent neglect, manage academic stress, and improve peer relationships. Furthermore, approaches should prioritize comprehensive interventions and long-term follow-up to improve adolescent mental health.

Keywords: Happiness, Adolescent, Stimulus, Depression, Social environment, Friendships.

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1. INTRODUCTION

Happiness is used interchangeably with such terms as life satisfaction, subjective well-being, and quality of life. People who consider themselves healthy tend to be more satisfied and expect happiness [1]. In South Korea, the expected happiness index for adolescents was the lowest among 22 OECD countries (Organization for Economic

Cooperation and Development) [2]. Middle and high school adolescents reported feeling "very much" and "a lot" of stress (females: 45.5%, males: 32.3%). Additionally, 26.8% of students felt sad or hopeless enough to stop daily activities for two weeks within the past 12 months [3]. Therefore, there is an urgent need to understand factors related to adolescents' low happiness and mental health and to make efforts to improve them.

Adolescents have a rebellious and chaotic developmental period due to the stress of academic life [4], and this has been reported to have a negative effect on their perceived happiness [5]. Adolescent happiness has been shown to help buffer the stress associated with developmental challenges [6], increase life satisfaction and self-esteem, and reduce anxiety and depressive symptoms [7]. Furthermore, a higher level of subjective happiness has many essential health benefits, such as reduced mortality and morbidity [8], and it is a significant indicator of positive development. Thus, it is important to evaluate the subjective happiness of adolescents.

Adolescent subjective happiness may depend on various environmental factors related to growth and development [9]. First, this period is susceptible to external stimuli that negatively influence subjective happiness, such as the suicide of family members, relatives, friends, social networks, and celebrities [10], school violence [11], and history of abuse [12]. Negative relationships with peers and teachers have been shown to reduce adolescents' ability to handle challenges and shortcomings, mobilize resources for optimal functioning, and maintain happiness [13].

Adolescent mental illness symptoms, such as aggressive behavior [14], depression [15], and atrophy and anxiety [16], appear during the stimuli reaction process, and these emotional channels influence subjective happiness. Adolescents perceived health status [17], self-esteem, frequency of contact with friends, and friend attachment [18] affect subjective happiness as a mode and resource to cope with stress [5].

Although it has been confirmed that various factors affect the subjective happiness of adolescents, most previous studies rely on cross-sectional surveys [1, 7, 18]. Therefore, understanding of the temporal sequence between variables is limited. It is important to explain the subjective happiness of adolescents experiencing rapid physical, cognitive, and emotional changes and to identify factors of longitudinal change.

This study aimed to investigate the factors associated with longitudinal changes in subjective happiness among Korean adolescents. Based on Roy's adaptation model [19], stimuli (school violence, abuse and neglect, academic stress, academic environment, school connectedness), cognator (depression and anxiety, withdrawal, aggressive behavior), self-concept (self-esteem), and role function (relation of peers) were evaluated for the effects on the subjective happiness of Korean adolescents.

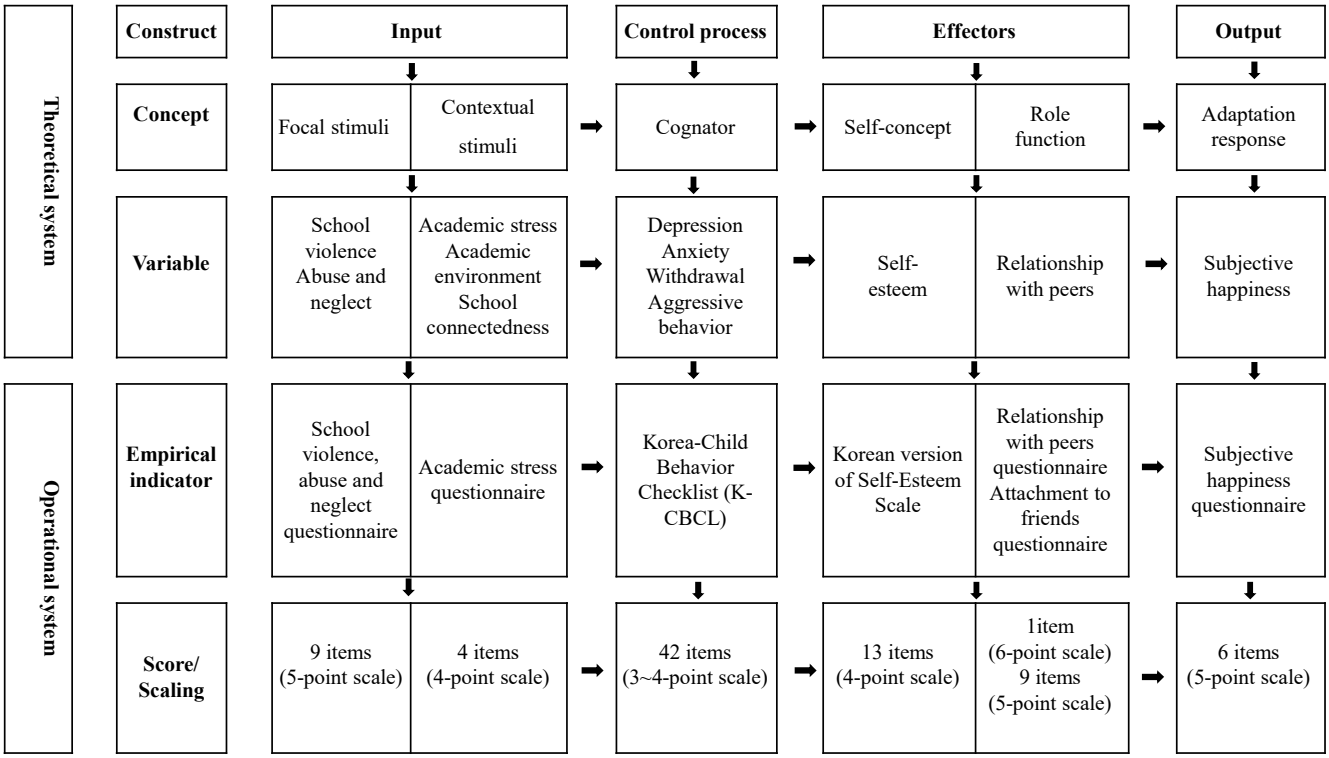

Fig. (1). Substruction of this study.

1.1. Review of Literature

Adolescent subjective happiness is affected by various factors. Therefore, the stimulus and the adaptive reaction processes associated with adolescent subjective happiness were examined separately, consistent with Roy's adaptation model. In Roy's adaptation model, an individual's response to environmental stimuli produces behavior. The adaptive problem begins when an individual cannot cope or respond to stimuli from internal and external environments [20]. The detailed variables according to substruction of this study are shown in Fig. (**1**).

2. MATERIALS AND METHODS

2.1. Design

This longitudinal study was to explore longitudinal changes in subjective happiness and to identify factors associated with subjective happiness according to the Roy's adaptation model.

2.2. Sample and Population

The data used in this secondary analysis came from the 2018 (Wave 13) and 2021 (Wave 16) Korea Welfare Panel Study (KoWePS) [21]. The Korea Welfare Panel, collected using a stratified random sampling method, was commissioned by the Ministry of Health and Welfare as a longitudinal nationally representative panel study and has been annual since 2006. KoWePS data, which targets households nationwide, includes the following wide range of topics: health and medical care, economic status, income and consumption, social satisfaction, well-being, *etc*. [21]. A supplementary survey has been conducted every three years since 2008 for children who are members of households included in this panel survey. The 2018 and 2021 data used for these analyses included a supplementary adolescent survey that targeted students over time. In 2018, the target group included all adolescents who were enrolled in grades 1, 2, and 3 of middle school at that time, and in 2021, as of March 2021, it included all adolescents enrolled in grades 1, 2, and 3 of high school. The participants were adolescents aged 14–16 years (students in the first–third years of middle school) who completed all questionnaires on subjective happiness, which is the dependent variable. All independent variables were collected in 2018, and the dependent variable was collected in 2021, respectively. The number of participants included in the final analysis is 324. The flow of participant selection in this study is shown in Fig. (**2**). The minimum sample size for this study was calculated using G*Power 3.1.9.7 for Windows, based on an effect size (f^2 = 0.32) derived from the explanatory power of a previous study [22], with a statistical power of 95% and an alpha level of 0.05, resulting in a sample size of 119.

2.3. Instruments

2.3.1. General Characteristics

General characteristics included age, sex, grade, family income, school credits, and whether the participant lives with their parents. Family income was converted to USD from KRW (as of July 8, 2022, USD 1$=KRW 1300). Demographic characteristics such as age, gender, grade level, family income, school credits, and living with parents were selected based on previous studies [1, 5, 7], as they significantly influence adolescent behavior and psychological state.

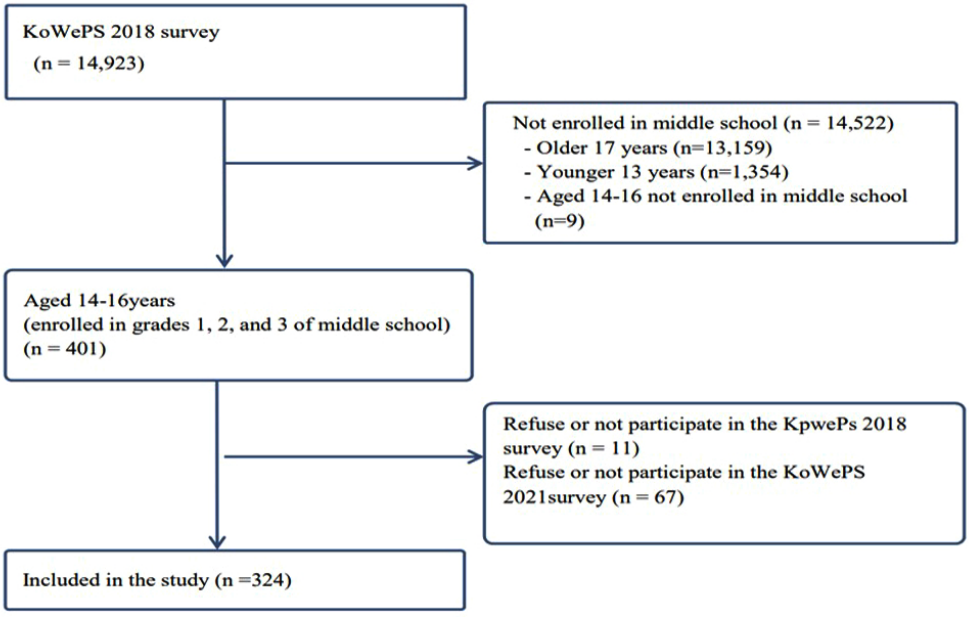

Fig. (2). Flowchart of this study.

2.3.2. Stimuli. Stimuli were Measured by Focal Stimuli and Contextual Stimuli

First, the focal stimuli were identified as school violence, abuse, and neglect. School violence was measured using Lee's [23] to measure the victim's experience of school violence and was measured with six single items. Each item was scored on a 4-point Likert scale, with a scale range of 6–24, with higher scores indicating greater experience of school violence. Abuse/neglect was measured using the items modified in the fourth wave of the survey (year 2009), which were developed by the Lee and Seoul Child Panel [24]. A total of eight items consisted of one item of physical abuse, three items of emotional abuse, and four items of neglect. Each item was scored on a 5-point Likert scale, with a scale range of 8–40, with higher scores indicating more severe child abuse/neglect.

Second, the contextual stimuli were identified as academic stress, academic environment, and school connectedness. Academic stress was measured using items in the seventh wave of the survey (the year 2012), developed by the Lee and Seoul Child Panel [24] and the Lee & Korea Youth Panel Survey [25]. Each item (*e.g.*, "I am stressed about having bad grades at school") was scored on a 4-point Likert scale, with a scale range of 4–16, with higher scores indicating higher school-related stress.Academic environment was measured in the first wave of the survey (the year 2006), using a nine-item question set (*e.g.*, "I enjoy school life." "I like most of the subjects I am learning."). Each item was scored on a 4-point Likert scale, with a scale range of 4–16, with higher scores indicating a positive perception of the school environment. School connectedness was measured in the fourth wave of the survey (year 2009), using the School Life Scale developed by Cavazos [26] and modified by Park [27]. This measure consists of six items, and each item was scored on a 4-point Likert scale, with a scale range of 4–16, with higher scores indicating higher school connectedness.

2.3.3. Control Process

People use coping mechanisms to respond to stimuli [28]. Among the control processes, aggressive behavior [14], depression [15], withdrawal, and anxiety [16], which correspond to emotional channels, affect subjective happiness. In this study, the control process of depression, anxiety, withdrawal, and aggressive behaviors were measured using the Korea-Child Behavior Checklist (K-CBCL), developed by Achenbach [29] and translated and modified by Oh *et al*. [30]. The K-CBCL consists of 14 items, and each item was scored on a 4-point Likert scale, with a scale range of 0–42, with higher scores indicating greater depression or anxiety. Each measure of depression and anxiety showed internal reliability at Wave 2 (α =0.91 and 0.83, respectively). As a sub-domain of the K-CBCL, withdrawal was investigated at the time of the survey and included 11 items, each of which was scored on a 3-point Likert scale, with a scale range of 11–33, with higher scores indicating higher withdrawal. Aggressive behavior was investigated at the time of the survey and was based on 19 items, each scored on a 3-point Likert scale, with a scale range of 19–57, with higher scores indicating more aggressive behavior.

2.3.4. Effectors

Effectors were measured by self-concept and role function. In this current study, the self-concept was evaluated by self-esteem, and the role function was evaluated by the relationship with peers and peer attachments. Self-esteem was measured using the Self-Esteem Scale, developed by [31] and translated and modified by Park [27]. The scale was based on the date at the time of the survey. The self-esteem scale included 13 items, and each item was scored on a 4-point Likert scale, with a scale range of 13–52, with higher scores indicating higher self-esteem. Relationship with peers was measured as the number of friends and peer attachments. The number of friends was measured using a single question, "How often do you meet with your close friends?" and was scored on a 6-point Likert scale. Attachment to friends was measured using the items in the fourth wave of the survey (the year 2009), developed by the Lee & Seoul Child Panel [24], and based on four items (*e.g.*, "I want to be friends with them for a long time."). Each item was scored on a 5-point Likert scale, with a scale range of 4–20, with higher scores indicating greater attachment to friends.

2.3.5. Output (Subjective happiness)

Subjective happiness was measured using the items in the seventh wave of the survey (the year 2012), developed by Youm [32], using the following six items: perceived health, school life, life satisfaction, belonging, getting along, and loneliness. Each item was scored on a 5-point Likert scale, with a scale range of 5–25, with higher scores indicating greater subjective happiness. In this study, Cronbach's alpha of subjective happiness was 0.83.

2.4. Statistical Analysis

Data analyses were conducted with SPSS/Win Statistics 21.0 (IBM Corp., Armonk, NY, USA). General characteristics, stimuli, control process, effectors, and subjective happiness were presented as descriptive statistics (frequency, percentage, mean, and standard deviation). The differences between categorical variables and subjective happiness were estimated using an independent t-test or one-way ANOVA. Correlations between continuous variables and subjective happiness were calculated using Pearson's correlation analysis. A hierarchical multiple linear regression was conducted to identify related factors of subjective happiness. Variables that were statistically significant in univariate analysis were included in the multivariate model according to our conceptual framework. The stimuli variables from the first step, the control process variables from the second step, and the variables from the third step were included. Sex, grade, school credits, family income, and living with parents were included as covariates in all steps. Before multivariate analysis, it was confirmed that assumptions about homoscedasticity, multicollinearity, and residuals

(normality and independence) were not violated. $p<0.05$ was considered statistically significant. Missing data were found to range from 0.9% to 1.5%. Since missing data below 10% is considered ignorable [33], no additional processing for missing data was conducted in this study.

3. RESULTS

Participant characteristics and subjective happiness baseline after three years are shown in Table **1**. The mean age of all 324 participants was 13.94 (SD±0.80) years, and females comprised 51.9% of participants. The subjective happiness scores at baseline (2018) and after three years (2021) were 25.10 (SD±4.00) and 19.56 (SD±3.49), respectively, showing a statistically significant difference (t=23.05, $p<.001$). All sub-domains of subjective happiness (perceived health, school life, life satisfaction, getting along, and loneliness), except for 'belonging', showed a significant decrease three years after the 2018 baseline (Table **S1-5**). The categorical variable associated with a significant difference in subjective happiness was school credits ($t=2.25$, $p=0.025$) (Table **2**).

In correlation analysis, variables that were significantly associated with subjective happiness at baseline were school violence, academic stress, academic environment, school connectedness, withdrawal, depression, self-esteem, number of friends, and peer attachment (Table **3**). Table **4** shows the results of three-step hierarchical models representing subjective happiness explained by independent variables. Multivariate analysis was performed by selecting variables based on Roy's adaptation theory and results from the

Table 1. Characteristics of participants and subjective happiness baseline and after three years (N=324).

Construct	Concept	Variable	M ± SD or n (%)	Range
-	General characteristics	Age	13.94 ±0.80	12-15
		Sex	-	-
		female	168 (51.9)	-
		Male	156 (48.1)	-
		Grade	-	-
		1st grade	101 (31.2)	-
		2nd grade	113 (34.9)	-
		3rd grade	110 (34.0)	-
		School credits	-	-
		Good	165 (50.9)	-
		Bad	159 (49.1)	-
		Family income (USD)	56850.69±29526.26	-
		Live with parents	-	-
		Yes	301 (92.9)	-
		No	20 (6.2)	-
		Missing	3 (0.9)	-
Input	Focal stimuli	School violence	6.54±1.20	6-13
		Domestic violence	-	-
		Physical abuse	-	-
		Yes	37 (11.4)	-
		No	282 (87.0)	-
		Missing	5 (1.5)	-
		Verbal abuse	3.50±1.54	3-14
		Neglect	4.15±0.79	4-12
	Contextual stimuli	Academic stress	8.26±2.83	4-16
		Academic environment	23.33±2.48	16-36
		School connectedness	16.17±1.70	10-24
		Aggressive behavior	21.51±3.49	19-38
		Withdrawal	11.33±2.90	9-26
Control process	Cognator	Depression &anxiety	17.56±4.20	14-37
Effectors	Self-concept mode	Self-esteem	34.83±3.34	23-52
	Role function	Relation with peer	-	-
		Number of friends	14.54±13.17	0-99
		Peer attachment	17.37±2.41	8-20
Output	Adaptation response	Subjective happiness in baseline	25.10±4.00	11-30
		Subjective happiness in after three years	19.56±3.49	9-25

Note: M±SD = Mean ± Standard deviation.

Table 2. Differences according to subjective happiness of categorical variables (N=324).

Concept	Variable	Subjective Happiness	
		M ± SD	*t* or F (*p*)
General characteristics	Sex	-	-
	female	19.91±3.43	1.74 (.084)
	Male	19.24±3.53	-
	Grade	-	-
	1st grade	20.09±3.21	0.69 (.185)
	2nd grade	19.36±3.43	-
	3rd grade	19.28±3.78	-
	School credits	-	-
	Good	19.99±3.50	2.25 (.025)
	Bad	19.12±3.44	-
	Living with parent	-	-
	Yes	21.74±3.60	-0.14 (.892)
	No	51.85±3.84	-
Focal stimuli	Domestic violence	-	-
	Physical abuse	-	-
	Yes	19.54±3.45	0.09 (.932)
	No	19.49±3.88	-

Note: M±SD = Mean ± Standard deviation.

univariate analyses. Models 1, 2, and 3 identify the predictor of subjective happiness after three years. Model 1 indicated that the stimuli factors account for 9.7% (Adj. R^2 = 0.10, F =4.39, p< .001) of the variability. The explanatory variability was increased by 2.2% (p<.001) and 3.8% (p<.001), respectively, according to the addition of control process factors and effector factors step by step. Thus, neglect (β =-0.11, p=.040), academic environment (β =0.15, p=.018), depression (β =-0.20, p=.013), and peer attachment (β =0.19, p=.001) significantly predicted subjective happiness at baseline and explained 14.5% (Adj. R^2=0.15) of its overall variability.

Table 3. Correlation according to subjective happiness of continuous variables (N=324).

Concept	Variable	1 r (*p*)	2 r (*p*)	3 r (*p*)	4 r (*p*)	5 r (*p*)	6 r (*p*)	7 r (*p*)	8 r (*p*)	9 r (*p*)	10 r (*p*)	11 r (*p*)	12 r (*p*)	13 r (*p*)	14 r (*p*)
General characteristics	Family income	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Focal stimuli	School violence	.02 (.691)	1	-	-	-	-	-	-	-	-	-	-	-	-
	Verbal abuse	.07 (.189)	.21 (<.001)	1	-	-	-	-	-	-	-	-	-	-	-
	Neglect	-.11 (.047)	-.04 (.511)	.12 (.031)	1	-	-	-	-	-	-	-	-	-	-
Contextual stimuli	Academic stress	.09 (.120)	.23 (<.001)	.25 (<.001)	.06 (.314)	1	-	-	-	-	-	-	-	-	-
	Academic environment	0.07 (.239)	-0.10 (.069)	-.15 (.008)	-.12 (.027)	-.20 (<.001)	1	-	-	-	-	-	-	-	-
	School connectedness	0.07 (.120)	-.10 (.068)	-.07 (.203)	.01 (.797)	-.15 (.008)	.38 (<.001)	1	-	-	-	-	-	-	-
	Aggressive behavior	.03 (.609)	.31 (<.001)	.36 (<.001)	.06 (.284)	.23 (<.001)	-.09 (.119)	.09 (.121)	1	-	-	-	-	-	-
	Withdrawal	-0.01 (.826)	.17 (.002)	.12 (.033)	.05 (.413)	.32 (<.001)	-.19 (.001)	-.02 (.768)	.37 (<.001)	1	-	-	-	-	-
Cognator	Depression & anxiety	0.03 (.636)	.31 (<.001)	.29 (<.001)	.02 (.70)	.41 (<.001)	-.14 (.012)	.02 (.677)	.62 (<.001)	.670 (<.001)	1	-	-	-	-
Self-concept mode	Self-esteem	-0.01 (.932)	.01 (.805)	.01 (.919)	.04 (.503)	-.11 (.058)	.37 (<.001)	.28 (<.001)	.04 (.472)	-.00 (.963)	-.04 (.523)	1	-	-	-
Role function	Number of friends	0.01 (.918)	-0.10 (.088)	-0.09 (.104)	0.05 (.363)	-0.04 (.427)	0.09 (.110)	0.10 (.074)	0.05 (.330)	-0.02 (.724)	-0.03 (.586)	0.12 (.039)	-	-	-
	Peer attachment	0.08 (.152)	0.07 (.898)	0.02 (.698)	.03 (.659)	-.12 (.036)	.29 (<.001)	.22 (<.001)	-.02 (.683)	-.22 (<.001)	-.05 (.376)	.26 (<.001)	0.15 (.007)	1	-

(Table 3) contd.....

Concept	Variable	1 r (*p*)	2 r (*p*)	3 r (*p*)	4 r (*p*)	5 r (*p*)	6 r (*p*)	7 r (*p*)	8 r (*p*)	9 r (*p*)	10 r (*p*)	11 r (*p*)	12 r (*p*)	13 r (*p*)	14 r (*p*)
Adaptation response	Subjective happiness	0.09 (.101)	-0.12 (.028)	-0.04 (.523)	-0.13 (.024)	-0.15 (.006)	0.28 (<.001)	0.15 (.005)	-0.07 (.241)	-0.20 (<.001)	-0.24 (<.001)	0.14 (.010)	0.14 (.012)	0.25 (<.001)	1

Table 4. Associated factors of subjective happiness (N=324).

Construct	Concept	Variable	Model 1	Model 2	Model 3
			β [95%CI], *p*	*β* [95%CI], *p*	*β* [95%CI], *p*
Input	Focal stimuli	School violence	-0.10 [-0.60, 0.03], .077	-0.06 [-0.48, 0.17], .335	-0.06 [-0.50, 0.14], .274
		Verbal abuse	-	-	-
		Neglect	-0.09 [-0.88, 0.70], .094	-0.09 [-0.88,0.07], .091	-0.11 [-0.96, -.02], .040
	Contextual stimuli	Academic stress	-0.05 [-0.20, 0.08], .416	0.01 [-0.14, 0.17], .847	0.02 [-0.12, 0.18], .698
		Academic environment	0.22 [0.14, 0.48],<.001	0.20 [0.10, 0.44], .002	0.15 [0.04, 0.39], .018
		School connectedness	0.03 [-0.17-0.30], .600	0.06 [-0.11, 0.36], .304	0.03 [-0.18, 0.29], .646
		Aggressive behavior	-	-	-
		Withdrawal	-	-0.01 [-0.18, 0.16], .924	0.05 [-0.12, 0.23], .541
Control process	Cognator	Depression & anxiety	-	-0.17 [-0.27, -0.01], .030	-0.20 [-0.29, -0.04], .013
Effectors	Self-concept mode	Self-esteem	-	-	0.01 [-0.11, 0.13], .848
	Role function	Number of friends	-	-	0.07 [-0.01, 0.05], .228
		Peer attachment	-	-	0.19 [0.11, 0.45], .001
-	-	-	Adj. R^2=.10, F=4.39, *p*<.001	Adj. R^2=.11, $\triangle R^2$= .02 F=4.39, *p*<.001	Adj. R^2=.15, $\triangle R^2$= .04 F=4.58, *p*<.001

Note: Covariate all model: sex, grade, family income, school credit, living with parent.

The assumption test for multiple regression and multicollinearity was performed for the independent variables, and the results were as follows: Durbin-Watson 2.05–2.10; tolerance 0.33–0.94; variance inflation factor 1.05–3.00.

4. DISCUSSION

This study explored longitudinal changes in factors associated with subjective happiness in Korean adolescents. Based on Roy's adaptation model, the stimuli and adaptive responses that affect subjective happiness among Korean adolescents were separately investigated. Specifically, the factors were divided into stimuli, control process, and effector processes, and an attempt was made to confirm the effect on longitudinal change of subjective happiness as an adaptive response.

In this study, the subjective happiness of participants was 22.71±3.64 in Wave 13 and decreased significantly to 19.56±3.49 in Wave 16 after three years. In further analyses, there was a statistically significant difference between the scores at the two-time points (t=23.05, p<0.001) (not shown). These results are similar to previous studies [34] that reported decreased life satisfaction for three years among 15-year-old students in 46 countries, including Korea. The decline in subjective happiness is a global phenomenon [34]. As of 2021, the mean level of life satisfaction among Korean adolescents is the lowest among OECD countries, and it is reported to be nine points lower than two years ago [2]. During the pandemic, there was a notable increase in sadness and suicide rates. In the mid-pandemic period, adolescents were significantly affected psychologically due to concerns about infection for themselves and their families, as well as the inconvenience of social isolation. These psychological burdens likely had a profound impact on adolescent mental health, leading to reports of lower levels of happiness [35]. Low happiness in adolescence is related to life satisfaction, low self-esteem, anxiety, and depression [7]. Our study did not include physical factors such as BMI, physical activity as determinants of subjective happiness [36,37], the bi-directional relationship between adolescent obesity and mental health, as well as the increased likelihood of overweight or obese adolescents experiencing social stigma and discrimination, suggest that future research should incorporate such factors. Furthermore, adolescents even attempt non-suicidal self-harm to cope with psychologically unpleasant emotions such as anxiety or depression [38]. On the contrary, high subjective happiness is an indicator of positive development and health benefits in adolescence, so a national policy-level approach is needed to improve adolescent subjective happiness.

In this study, among the stimuli, a positive perception of the academic environment positively affected subjective happiness after three years. According to a systematic review, the psychosocial school climate (environment) was closely related to well-being and mental health [39], which supports the results of the present study. It is difficult to compare the school environment directly with the one defined in a previous study because of the slight difference in definitions. However, a negative school environment in adolescence leads to health-risk behaviors, such as smoking, drinking, and bullying. In contrast, a socially supportive environment with friends and family improves

mental well-being and alleviates depression and anxiety [40]. Therefore, to improve the subjective happiness of adolescents, comprehensive and effective policies, including improvement of the social support system and school-level improvements, are needed [41].

Among the control process variables, only depression was significant in longitudinal trends, which was similar to previous studies [7, 22]. People use their coping processes to respond to external stimuli [28]. Depression is one of these emotional channels, and this study confirms that adolescent depression affects subjective happiness [15]. According to a systematic review, depression in adolescence not only increases the probability of developing depression in adulthood by 2.78 times but has also a significant association with suicidal ideation [42]. Appropriate interventions for depressed adolescents may reduce the burden associated with psychological disorders in adulthood. In particular, the current COVID-19 pandemic is aggravating depression and anxiety in adolescents [43]. A systematic umbrella review of the literature on physical activity and mental health complications reported that participation in group exercise or sports not only offers opportunities for socialization but also helps reduce feelings of loneliness and isolation linked to mental health issues [37]. It is necessary to alleviate the psychological burden of depression and anxiety in adolescents by approaching interventions in various ways that reflect one's current situational characteristics [43]. Adaptive problems signal that a person cannot cope with or respond to stimuli from their external environment [20]. Therefore, it is necessary to screen early and provide intensive management for adolescent depression, which is related to suicidal ideation [44].

The effector is a process of coping with a change in environment and is classified as an adaptive mode [19]. In this study, among the various adaptation modes, peer attachment was also identified as an associated factor of subjective happiness after three years of follow-up. The finding that peer relations affect subjective happiness is consistent with previous studies [22, 45]. Adolescents form a strong emotional bond with their school peers [46], and interpersonal relationships strongly affect subjective happiness [47]. Lereya *et al*. reported peer support as a factor affecting subjective happiness in the first year of adolescence (11–12 years old). Adolescents with strong external support and good peer relationships experienced better subjective well-being [45]. Because peer attachment affected subjective happiness after three years in this study, it is necessary to activate various support programs so that adolescents can form positive friendships in school. This study had some limitations. The present study relied on secondary data, which limited variable selection. Therefore, these results should be interpreted with caution. This study aimed to examine whether the 2018 baseline variables, based on Roy's adaptation model, influenced subjective happiness, the dependent variable, in 2021. Consequently, relevant factors such as grade, school, and income in 2021 cannot be used to explain their potential effects on subjective happiness in that year. Furthermore, we did not control for the effect of subjective happiness in 2018 on the 2021 outcome, emphasizing the need for further research that addresses these considerations. In addition, even if this study was conducted based on the Roy adaptation theory, only the variables of some concepts of theory were applied. We proposed further research, including all the concepts of the theory in this population. Despite these limitations, this study identified longitudinal factors associated with subjective happiness based on Roy's adaptation theory in a nationally representative sample.

CONCLUSION

This study was conducted to estimate the degree of subjective happiness of Korean adolescents and to identify related factors based on Roy's adaptation theory. The degree of subjective happiness of Korean adolescents was lower than in other countries, and variables related to stimuli (academic environment), cognator (depression and anxiety), and role function (peer attachment) were identified as associated. These results emphasize the need for interventions to enhance emotional support, prevent neglect, manage academic stress, and improve peer relationships. In this study, we identified the relationship between subjective happiness, the educational environment, and psychological factors. However, further research is warranted to incorporate physical factors and examine long-term trends for a more comprehensive understanding. Subjective happiness in adolescence is an indicator of positive development. Therefore, it is necessary to improve the subjective happiness of adolescents at the national policy level.

AUTHORS' CONTRIBUTIONS

J.-E.Y.: Contributed to Conceptualization, Methodology, writing-original draft preparation, reviewing, and editing; S.M.: Contributed to Resources, Data curation, writing-original draft preparation, reviewing, and editing.

LIST OF ABBREVIATIONS

OECD	=	Organization for Economic Cooperation and Development
KoWePS	=	Korea Welfare Panel Study
KRW	=	Korea Won
K-CBCL	=	Korea-Child Behavior Checklist

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Prior to data analysis, authors obtained the Institutional Review Board exemption from the Public Institutional Bioethics Committees in Korea (IRB No. P01-202208-01-003).

HUMAN AND ANIMAL RIGHTS

All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and

national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

In this study, we utilize information within the scope of previously obtained consent, and do not directly recruit research participants. Given that obtaining consent is not feasible, there is no process for acquiring additional consent.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of the article are available in the [Korea Welfare Panel Study (KoWePS)] at [https://www.koweps.re.kr:442/data/data/list.do], reference number [Research report 2018-38, 2021-18], reference number [21].

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CONFLICT OF INTEREST

The author(s) declare no conflict of interest, financial or otherwise.

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SUPPLEMENTARY MATERIAL

Supplementary material, along with the published article, is available on the publisher's website.

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