Relationships between milk consumption and academic performance, learning motivation and strategy, and personality in Korean adolescents

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BACKGROUND/OBJECTIVES: A healthy diet has been reported to be associated with physical development, cognition and academic performance, and personality during adolescence. This study was performed to investigate the relationships among milk consumption and academic performance, learning motivation and strategies, and personality among Korean adolescents.
SUBJECTS/METHODS: The study was divided into two parts. The first part was a survey on the relationship between milk consumption and academic performance, in which intakes of milk and milk products and academic scores were examined in percentiles among 630 middle and high school students residing in small and medium-sized cities in 2009. The second part was a survey on the relationships between milk consumption and learning motivation and strategy as well as personality, in which milk consumption habits were collected and Learning Motivation and Strategy Test (L-MOST) for adolescents and Total Personality Inventory for Adolescents (TPI-A) were conducted in 262 high school students in 2011.
RESULTS: In the 2009 survey, milk and milk product intakes of subjects were divided into a low intake group (LM: $\leq$ 60.2 g/day), medium intake group (MM: 60.3-150.9 g/day), and high intake group (HM: $\geq$ 151.0 g/day). Academic performance of each group was expressed as a percentile, and performance in Korean, social science, and mathematics was significantly higher in the HM group ($P < 0.05$). In the 2011 survey, the group with a higher frequency of everyday milk consumption showed significantly higher "learning strategy total," "testing technique," and "resources management technique" scores ($P < 0.05$) in all subjects. However, when subjects were divided by gender, milk intake frequency, learning strategy total, class participation technique, and testing technique showed significantly positive correlations ($P < 0.05$) in boys, whereas no correlation was observed in girls. Correlations between milk intake frequency and each item of the personality test were only detected in boys, and milk intake frequency showed positive correlations with "total agreeability", "organization", "responsibility", "conscientiousness", and "intellectual curiosity" ($P < 0.05$).
CONCLUSION: Intakes of milk and milk products were correlated with academic performance (Korean, social science, and mathematics) in Korean adolescents. In male high school students, particularly, higher milk intake frequency was positively correlated with learning motivation and strategy as well as some items of the personality inventory.

INTRODUCTION

Adolescence, a period of rapid growth in physical, emotional, and social capabilities, requires balanced nutritional intake [1] and has the highest nutrient requirements in the entire lifecycle [2]. A healthy diet has been reported to be related to physical development and cognition, academic performance [3], and personality [4] during adolescence.

According to the 2012 Fifth Korean National Health and Nutrition Survey (KNHANES V), nutritional insufficiency in adolescents aged 12-18 years was measured as 17.0%, which was the second highest after 17.1% in those aged 19-29 years [5]. Particularly, calcium intake in adolescents was found to be only 56% of the recommended nutrient intake, which was the lowest intake rate among all nutrients and the lowest ratio in terms of recommended nutrient intake compared to calcium intakes in other age groups. Calcium insufficiency in Korean adolescents is related to insufficient milk consumption. Although the first source food for calcium in adolescents is milk, the 2012 KNHANES V reported that the ratios of milk consumption in

middle and high school students were 17.4% and 9.1%, respectively, which were lower than that of carbonated beverages (23.5% and 23.0%, respectively). Kim [6] reported that intakes of energy, animal protein, lipids, carbohydrates, calcium, phosphorus, potassium, and vitamin A were higher in students eating school meals, including milk. Kim *et al*. [7] also reported that intakes of energy, protein, vitamins, and minerals were significantly higher in adolescents with higher milk consumption compared to those with lower milk consumption, suggesting that consumption of milk and milk products can increase intake of not only calcium but also overall nutrient intake. Therefore, milk consumption can be an effective method to improve nutritional status in adolescents.

It has been reported that milk intake shows a positive relationship with children's height [8], and milk consumption was shown to increase bone density particularly in female students [9], suggesting that milk consumption plays a positive role in the physical development of adolescents.

Adolescence is also a period of intellectual and emotional development along with physical growth. In the case of Korea, there is high interest in school-based learning, and thus studies regarding the effect of milk consumption on academic performance have great significance. However, studies on the relationship between milk consumption in adolescents and academic performance and personality are very limited. Han *et al*. [10] reported that intakes of calcium, vitamin A, and riboflavin showed significantly positive correlations with academic achievement in Korean elementary and middle school students. Hulett *et al*. [11] analyzed the relationship between food sources and academic performance in Kenya and reported that students who consumed meat had significantly increased scores in arithmetic, English, Kiembu, Kiswahili, and geography while students reporting milk consumption had significantly higher scores in English, Kiswahili, and geography compared to the control group with plant food consumption. However, MacLellan *et al*. [12] reported that higher intakes of vegetables, fruits, and milk did not significantly increase academic scores among high school students.

Until now, studies on the relationship between milk consumption and academic performance and personality in Korean adolescents have been limited. Thus, this study was performed to investigate the relationship between intakes of milk and milk products and academic performance, learning motivation and strategy, and personality among Korean adolescents.

SUBJECTS AND METHODS

Study design and subjects

The study was divided into two parts. The first part was a survey conducted in 2009 on the relationship between milk consumption and academic performance in adolescents. The second part was a survey conducted in 2011 on the relationship between milk intake frequency, learning motivation and strategy, and personality among adolescents. In 2009, a total of 630 middle and high school students, aged 15-16 years, were surveyed. The subjects in 2009 were male and female students aged 15-16 years, mostly 9th grade (middle school) students and 10th grade (high school) students. Schools located in large

cities, small and medium-sized cities, and eup / myeon principal were selected, and schools demonstrating possible cooperation of principal, teachers, and students were finally selected. Residence location of participants included the Daejeon metropolitan district (large urban area), Chungnam Gongju (small and middle urban areas), and Gyeonggi-do Pyeongtaek (eup · myeon area). Other details of subjects in 2009 were as described in previous studies [7,9].

The 262 male and female subjects for the 2011 survey on the relationship among learning motivation, strategy, and personality were selected from high school students participating in the 2009 survey by following and confirming their school attendance, and their milk consumption habits were unchanged over these 2 years. All middle school students participating in 2009 attended different high schools and were difficult to follow. The survey was conducted in July 2011. The subjects participated in this study after they signed a written copy of information. This study was approved by the Institutional Review Board of Hannam University (2013-03k).

Milk and milk product intake

Intakes of milk and milk products among the participants in 2009 were obtained by dietary record, which was conducted for 3 days, including two weekdays and one weekend day [9]. The subjects were instructed to fill out the dietary record with their intakes of various kinds of milk and milk products such as white milk, flavored milk, liquid-type yogurt, curd-type yogurt, and cheese for 3 days. Total calcium intake was calculated using the computer-aided nutritional analysis program (CAN) pro 3.0 developed by the Korean Nutrition Society. Total calcium intake was compared with the Korea Dietary Reference Intake (KDRI) [2] for each participant's age.

After subjects were divided into three groups based on daily milk and milk product intakes, low group ($\leq$ 60.2 g/d), medium group (60.3-150.9 g/d), and high group ($\geq$ 151.0 g/d), the relationships between daily intakes of milk and milk products and academic performance were determined.

In 2011, everyday milk consumption habits among high school students were surveyed by asking how they drank white milk in the past year with answers ranging as follows: more than one cup/day, five to six cups/week, three to four cups/week, one to two cups/week, or less than one cup/week.

Academic performance

Academic performance of the students in 2009 was surveyed to determine the percentile of each subject. The percentile of a student was expressed by rounding off to two decimal places the percentage of students with lower average scores than that of the average student. The subjects included Korean, ethics, social science, mathematics, science, technology, home economics, and English.

Learning motivation and strategy test (L-MOST) for adolescents and total personality inventory for adolescent (TPI-A)

The learning motivation of adolescents was studied using the Learning Motivation and Strategy Test (L-MOST) in 262 high school students, and the personality of adolescents was investigated using the Total Personality Inventory for Adolescent

(TPI-A) questionnaire. L-MOST is generally used in high schools for assessment of adolescent's learning behavior, psychological counseling, and career aptitude guidance [13], whereas TPI-A is used for understanding adolescents psychological counseling, and career aptitude guidance [14]. L-MOST and TPI-A survey tools were developed by the Korea Psychological Service (KPO). The time taken for each questionnaire was 45 minutes, and analysis of the questionnaire was requested to the KPO. Specialists graded and interpreted the results, which were then returned with T scores for further statistical analysis of this study. The T score was calculated as follows: if the T score is high, that variable has a tendency to be large or high.

T score = 10Z + 50, Z score = original score-mean/SE

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Science program (SPSS; Chicago, USA). For age, height, weight, and BMI, the mean and standard of error (SE) were obtained according to school and sex. Difference in general characteristics between boys and girls was tested for significance using student's T-test. Intakes of milk and milk products were divided into three groups. The mean and standard error (SE) were calculated for academic performance, L-MOST, and TPI-A scores according to milk intake. One-way ANOVA was performed to determine the significance among the groups, and Tukey's multiple range test was performed to confirm significance. Correlations between milk intake frequency and L-MOST and TPI-A scores were tested by obtaining Pearson correlation coefficients.

RESULTS

General characteristic of subjects

General characteristics of the subjects in 2009 are shown in Table 1. The total number of subjects was 630, including 333 middle school students (115 boys and 218 girls) and 297 high school students (138 boys and 159 girls). Height and weight were significantly higher in boys than in girls for both middle and high school students ($P < 0.05$), whereas BMI was not different between boys and girls. In the 2011 survey, the number of subjects was 262 high school students, including 121 boys and 141 girls.

Milk and milk product intakes

Milk and milk product intakes of the subjects were divided into three groups: low milk intake group (LM) at ≤ 60.2 g/day, medium milk intake group (MM) at 60.3-150.9 g/day, and high milk intake group (HM) at ≥ 151.0 g/day (Table 2). Total calcium intake from diet, including milk and milk products, of subjects was calculated as the intake ratio for KDRI [2] for each age group, with LM being less than 73.0%, MM 73.1-95.5%, and HM over 95.6%.

Academic performance

The percentile of academic scores of subjects according to intakes of milk and milk products is shown in Table 3. Students with higher milk and milk product consumption showed significantly higher scores in Korean, social science, and mathe-

Table 1. General characteristics of middle and high school students in 2009[1]

	Total	Middle school		High school	
		Boys	Girls	Boys	Girls
N (%)	630 (100.0)	115 (18.3)	218 (34.6)	138 (21.9)	159 (25.2)
Age (yrs)	15.2 ± 0.2[2]	15.0 ± 0.0	15.0 ± 0.0	15.4 ± 0.0	15.4 ± 0.0
Height (cm)	163.9 ± 0.3	169.4 ± 0.5*[3]	158.7 ± 0.4	171.0 ± 0.5*	161.0 ± 0.4
Weight (kg)	57.7 ± 0.4	60.4 ± 1.2*	54.4 ± 0.7	63.5 ± 0.8*	55.2 ± 0.6
BMI (kg/m²)	21.4 ± 0.1	21.0 ± 0.4	21.6 ± 0.2	21.7 ± 0.3	21.3 ± 0.2

[1] Same as in previous studies [7,9]
[2] Mean ± SE
[3] There is a significant difference between boys and girls by Student T-test at α = 0.05.

Table 2. Milk and milk product intakes and total calcium intakes of middle and high school students in 2009

	Low (n = 206)	Medium (n = 212)	High (n = 212)
Milk and milk product intakes (g/day)	16.3 ± 1.9[1)c2)]	99.7 ± 2.0[b]	284.1 ± 11.1[a]
Total calcium intake (mg/day)	289.6 ± 7.7[c]	397.1 ± 10.3[b]	572.2 ± 14.7[a]
Percentage of total calcium intake for KDRI[3]	34.7 ± 1.0[c]	47.2 ± 1.2[b]	67.9 ± 1.6[a]

[1] Mean ± SE
[2] There is a significantly difference among groups by Tukey's test at a = 0.05.
[3] KDRI: Korea dietary reference intake [2]

Table 3. Academic scores expressed by percentile according to milk and milk products intakes of middle and high school students in 2009

Subjects	Total (n = 630)	Low (n = 206)	Medium (n = 212)	High (n = 212)
Korean	52.2 ± 1.1[1]	47.8 ± 2.1[b2]	53.6 ± 1.9[ab]	54.9 ± 2.0[a]
Ethics	52.4 ± 1.1	49.1 ± 2.0	53.0 ± 1.9	54.8 ± 2.0
Social science	52.9 ± 1.1	48.2 ± 2.0[b]	55.7 ± 1.8[a]	54.4 ± 2.0[a]
Mathematics	52.7 ± 1.1	48.1 ± 2.0[b]	54.6 ± 1.9[a]	54.9 ± 2.0[a]
Science	52.2 ± 1.1	48.7 ± 2.0	53.2 ± 1.8	54.3 ± 2.0
Technology and Home economics	52.7 ± 1.1	49.2 ± 2.0	54.3 ± 1.9	54.5 ± 2.0
English	52.6 ± 1.1	49.3 ± 2.0	54.1 ± 1.9	54.0 ± 2.0

[1] Mean ± SE
[2] There is a significant difference among groups of milk and milk product intakes by Tukey's multiple range test at α = 0.05.

matics ($P < 0.05$). However, no score difference was observed in ethics, science, technology, home economics, or English depending on consumption of milk and milk products.

Milk intake frequency and L-MOST and TPI-A

The L-MOST scores according to milk intake frequency in high school students surveyed in 2011 are shown in Table 4. Regarding milk intake frequency of high school students, 61 students consumed less than one cup/week, 111 students had two to six cups/week, and 90 students had more than one cup/day. Regarding average L-MOST scores by milk intake frequency, students with higher milk intake frequency had significantly higher scores in the following areas: testing technique, resources management technique, and learning strategy total ($P < 0.05$). Correlations between milk intake frequency and L-MOST scores in boys and girls are shown in Table 5. Overall, milk intake frequency showed significant

Table 4. Learning motivation and strategy test (L-MOST) score according to frequency of milk consumption of high school students in 2011

		Total (n = 262)	≤ 1 cup/week (n = 61)	2-6 cup/week (n = 111)	≥ 1 cup/day (n = 90)
Learning motivation	Learning motivation	51.7 ± 0.5[1]	49.7 ± 1.1	51.7 ± 0.9	53.0 ± 1.0
	Learning efficacy	51.6 ± 0.5	50.1 ± 1.0	51.6 ± 0.9	52.3 ± 0.9
	Total	51.6 ± 0.4	49.9 ± 0.9	51.6 ± 0.8	52.6 ± 0.8
Learning strategy	Class participation technique	47.1 ± 0.5	46.0 ± 1.1	47.1 ± 0.9	48.4 ± 1.0
	Note-organizing technique	48.9 ± 0.5	47.2 ± 1.1	49.0 ± 0.8	49.7 ± 0.9
	Reading technique	51.4 ± 0.5	50.0 ± 1.0	51.1 ± 0.7	52.0 ± 0.9
	Writing technique	51.0 ± 0.5	48.4 ± 1.2	51.4 ± 0.8	51.1 ± 0.9
	Testing technique	50.2 ± 0.5	47.6 ± 1.1[b2)]	50.2 ± 0.9[ab]	51.6 ± 1.0[a]
	Resources management technique	51.8 ± 0.5	50.3 ± 1.1[b]	51.2 ± 0.8[ab]	53.5 ± 0.9[a]
	Project-solving technique	49.6 ± 0.6	48.0 ± 1.1	49.2 ± 1.0	50.8 ± 1.1
	Information processing technique	50.4 ± 0.5	49.4 ± 1.1	50.3 ± 0.8	50.9 ± 1.0
	Total	50.1 ± 0.4	48.4 ± 0.8[b]	49.9 ± 0.6[ab]	51.0 ± 0.8[a]
Emotion	Test anxiety	49.8 ± 0.6	50.2 ± 1.2	50.4 ± 0.9	49.4 ± 1.1
	Attention deficit	51.9 ± 0.5	52.2 ± 1.1	52.3 ± 0.8	51.1 ± 1.0
	Total	50.8 ± 0.4	51.2 ± 0.9	51.4 ± 0.7	50.3 ± 0.8

[1] Mean ± SE
[2] There is a significant difference among groups in frequency of milk consumption by Tukey's multiple range test at α = 0.05.

Table 5. Correlations between learning motivation and strategy test (L-MOST) score and frequency of milk consumption of high school students in 2011

		Total (n = 262)	Boys (n = 121)	Girls (n = 141)
Learning motivation	Learning motivation	0.118	0.124	0.042
	Learning efficacy	-0.038	0.010	0.104
	Total	0.105	0.073	0.080
Learning strategy	Class participation technique	0.107	0.187*[1]	-0.001
	Note-organizing technique	0.088	0.120	-0.012
	Reading technique	0.093	0.150	0.020
	Writing technique	0.113	0.123	0.058
	Testing technique	0.116	0.203*	-0.030
	Resources management technique	0.130*	0.174	-0.058
	Project-solving technique	0.109	0.168	0.093
	Information processing technique	0.055	0.136	-0.030
	Total	0.128*	0.208*	0.009
Emotion	Test anxiety	-0.014	0.050	-0.051
	Attention deficit	-0.047	-0.065	-0.064
	Total	-0.038	-0.008	-0.070

[1] There is a significant correlation between Learning Motivation and Strategy Test (L-MOST) score and frequency of milk consumption by Pearson's correlation test at α = 0.05.

Table 6. Total personality inventory for adolescent (TPI-A) score according to frequency of milk consumption in high school students in 2011

		Total (n = 262)	≤ 1 cup/week (n = 61)	2-6 cup/week (n = 111)	≥ 1 cup/day (n = 90)
Extraversion	Sociability	49.6 ± 0.5[1]	49.0 ± 1.3	48.4 ± 0.8	50.8 ± 1.0
	Dominance	50.2 ± 0.5	51.7 ± 1.3	49.5 ± 0.9	49.9 ± 1.0
	Novelty seeking	50.4 ± 0.6	49.7 ± 1.3	49.6 ± 0.8	51.8 ± 1.2
	Total	50.0 ± 0.4	50.1 ± 1.1	49.2 ± 0.6	50.8 ± 0.8
Agreeableness	Credibility	49.8 ± 0.5	48.7 ± 1.2	49.9 ± 0.9	50.1 ± 1.0
	Tolerance	49.4 ± 0.6	48.6 ± 1.4	49.6 ± 0.9	49.6 ± 1.1
	Altruism	53.0 ± 0.5	52.1 ± 1.1	52.9 ± 0.8	53.1 ± 0.9
	Total	50.8 ± 0.4	49.8 ± 0.9	50.9 ± 0.7	51.0 ± 0.8
Conscientiousness	Competence	52.5 ± 0.5	52.1 ± 1.2	52.0 ± 0.8	53.0 ± 1.0
	Organizability	53.7 ± 0.6	54.4 ± 1.2	52.4 ± 1.0	55.0 ± 1.2
	Conformity	52.1 ± 0.5	50.8 ± 1.2	52.1 ± 0.8	52.2 ± 1.1

Table 6. continued

		Total (n = 262)	≤ 1 cup/week (n = 61)	2-6 cup/week (n = 111)	≥ 1 cup/day (n = 90)
	Responsibility	53.3 ± 0.5	52.7 ± 1.1	53.0 ± 0.8	53.9 ± 1.1
	Total	52.9 ± 0.4	52.6 ± 0.9	52.4 ± 0.6	53.5 ± 0.8
Openness to experience	Creativity	49.9 ± 0.5	50.0 ± 1.1	49.1 ± 0.8	50.2 ± 1.0
	Intellectual curiosity	51.0 ± 0.6	50.3 ± 1.0	50.2 ± 0.8	52.0 ± 1.2
	Total	50.4 ± 0.5	50.2 ± 0.9	49.6 ± 0.7	51.1 ± 0.9
Neuroticism	Anxiety	50.0 ± 0.6	48.9 ± 1.3	50.9 ± 0.9	49.9 ± 1.1
	Depression	50.1 ± 0.5	50.0 ± 1.0	50.5 ± 0.8	50.6 ± 1.1
	Impulsivity	50.1 ± 0.5	50.8 ± 1.3	49.4 ± 0.9	50.7 ± 1.2
	Total	50.1 ± 0.4	49.9 ± 0.9	50.3 ± 0.7	50.4 ± 0.9
Life adjustment	Self-respect	51.2 ± 0.5	51.5 ± 1.0	50.7 ± 0.8	51.0 ± 1.0
	Peer-relation satisfaction	49.9 ± 0.5	49.2 ± 1.2	49.9 ± 0.8	50.6 ± 1.0
	Family-relation satisfaction	52.1 ± 0.5	51.1 ± 1.1	52.0 ± 0.7	52.0 ± 1.0
	Stress	48.5 ± 0.5	48.6 ± 1.1	49.2 ± 0.9	48.4 ± 1.0
	Aggression	51.4 ± 0.5	52.5 ± 1.7	51.4 ± 0.9	52.2 ± 1.2
	Delinquency action	49.3 ± 0.5	49.6 ± 1.3	48.9 ± 0.8	50.6 ± 1.0
	Suicidal ideation	48.9 ± 0.5	48.8 ± 1.1	49.2 ± 0.8	49.3 ± 1.1

[1] Mean ± SE

Table 7. Correlations between total personality inventory of adolescent (TPI-A) score and frequency of milk consumption in high school students in 2011

		Total (n = 262)	Boys (n = 121)	Girls (n = 141)
Extraversion	Sociability	0.076	0.177	-0.004
	Dominance	-0.037	0.076	-0.001
	Novelty seeking	0.077	0.016	0.056
	Total	0.049	0.120	0.022
Agreeableness	Credibility	0.042	0.176	-0.001
	Tolerance	0.037	0.138	0.047
	Altruism	0.042	0.114	0.004
	Total	0.053	0.183*[1]	0.022
Conscientiousness	Competence	0.040	0.110	0.112
	Organizability	0.056	0.186*	0.005
	Conformity	0.068	0.064	0.132
	Responsibility	0.058	0.191*	0.093
	Total	0.072	0.194*	0.108
Openness to experience	Creativity	0.020	0.052	0.049
	Intellectual curiosity	0.085	0.180*	0.157
	Total	0.063	0.140	0.121
Neuroticism	Anxiety	0.016	-0.079	-0.002
	Depression	0.035	-0.024	0.015
	Impulsivity	-0.026	-0.026	-0.099
	Total	0.013	-0.055	-0.031
Life adjustment	Self-respect	-0.025	0.073	-0.001
	Peer-relation satisfaction	0.064	0.138	0.028
	Family-relation satisfaction	0.000	0.013	-0.016
	Stress	-0.005	-0.054	-0.001
	Aggression	0.019	0.087	0.033
	Delinquency action	0.032	0.015	0.050
	Suicidal ideation	0.030	0.075	-0.065

[1] There is a significant correlation between total personality for adolescent (TPI-A) score and frequency of milk consumption by Pearson's correlation test at α = 0.05.

positive correlation with resource management technique and learning strategy ($P < 0.05$). However, this correlation showed differences by gender; milk intake frequency in boys showed significant positive correlations with class participation technique, testing technique, and learning strategy ($P < 0.05$), whereas no significance was observed in girls.

The average TPI-A scores in high school students were not different by milk intake frequency (Table 6). However, according to gender, milk intake frequency showed positive correlations with total agreeability, organization, responsibility, conscientiousness, and intellectual curiosity ($P < 0.05$) (Table 7), whereas no correlation with any of the TPI-A items was observed in girls.

DISCUSSION

The study was performed to investigate the relationship between milk consumption and academic performance in middle and high school students as well as the relationship among milk intake frequency, learning motivation and strategy, and personality in high school students.

Previous studies on Korean adolescents reported that higher milk consumption could improve overall nutritional status in addition to calcium intake [6], and milk consumption was shown to positively influence physical growth, including bone density improvement [9]. In Korean adolescents, the ratios of students who consumed milk were 18.8% and 11.4% in middle and high school students in 2006, respectively, whereas they decreased yearly to 17.4% and 9.1% by 2015, respectively [5]. Daily intake of milk in Korean children and adolescents was shown to decrease by age as well as differ by gender [15]. Daily milk intakes of 265.9 g and 275.7 g were reported in boys aged 6-11 years and 12-18 years, respectively, with no significant difference. Meanwhile, daily milk intake in girls was reported to be 218.2 g from 6-11 years, decreasing to 142.3 g from 12-18 years and showing significant reduction by age [15]. In the USA, the ratio of female students who consumed milk was 72% (mean intake 303 g/day) in those aged 12-19 years in 1977-1978 but decreased to 50% (mean intake 189 g/day) in 1994-1996, along with inadequate intakes of calcium, vitamin A, phosphorus, folate, and magnesium in girls who did not consume milk [16]. Thus, milk consumption in adolescents is closely related to not only calcium intake but also nutritional status and physical development. Since milk consumption in Korean adolescents is very low, multi-dimensional studies on milk consumption are needed.

The cognitive ability and learning ability of adolescents are affected by several factors, such as school quality (facilities, teaching quality, teaching time), family characteristics (socioeconomic status, parent's education level, parents' attitude toward school), individual characteristics (attitude, motivation, behavior, genetics) [17], and nutrient intake [18,19].

Previous studies reported that children with malnutrition or insufficient intake of micro-nutrients show suppressed learning and behavioral development compared to those with sufficient intakes [20,21]. Regarding the cognitive ability of children by nutritional status, malnourished children score poorer in school compared to control children with good nutrition [22] as well as show shorter playing time with toys in terms of behavior [23]. For individual nutrients, iron insufficiency was shown to be related to disadvantages in learning ability, whereas lower blood iron and folate concentrations are related to significantly lower academic performance in female adolescents [24]. On the other hand, no clear evidence was reported regarding the effect of insufficient zinc and iodine intakes on learning ability [25].

There have been few studies on the relationships between milk consumption or calcium intake and learning ability. One study conducted in Korea showed that the academic performance of male middle school students increased in the order of groups with less than 75%, over 125%, and 75-125% of recommended calcium intake, suggesting the importance of proper calcium intake for academic performance [10]. In American male and female students aged 11-13 years, intake of more than 600 ml of milk/day was shown to be related to significantly higher math scores compared to intake of less than 600 ml, and students showed higher reading scores. However, students that consumed over 360 ml of sweetened beverages/day showed significantly lower math and reading scores compared to those who consumed less than 360 ml, suggesting that milk rather than sweetened beverage consumption can positively affect math and reading scores [26].

In a Kenyan intervention study, a group consuming 250 ml of milk/day showed significantly increased academic scores in English, Kiswahili, and geography [11]. On the other hand, another study reported that milk consumption is not related to academic achievement [12]. In the results of this study, higher intakes of milk and milk products in adolescents were related to significantly higher scores in Korean, social science, and mathematics. These results seem to be partially related to high scores in testing technique, resource management technique, and learning strategy in the case of higher intakes of milk and milk products. It appears that adolescents with higher milk consumption showed higher scores in learning strategy measures such as testing technique or resource management technique, which act as factors to increase academic scores in Korean, social science, and mathematics. However, more in-depth studies should be conducted to establish for direct correlations among them.

In a study on middle school students using a Big Five Model with five dimensions of personality characteristics such as conscientiousness, extraversion, neuroticism, openness to experience, and agreeableness [27], personality characteristics significantly affected peer adaptation, study adaptation, living adaptation, and teacher adaptation, suggesting that personality greatly influences learning and daily life [28].

Individual personality is closely related to learning and also dietary intakes. This relationship is influenced by several factors, including demographic factors and lifestyle [29]. The relationship between personality and diet in adolescents has been studied in relation to eating disorders [30,31], whereas studies on the relationship between milk consumption and personality are very limited.

Petrescu and Vlaicu reported that aggressiveness in adolescents is significantly related to intake of butter/lard, juices, and fried potatoes [4]. A higher stress recognition rate was observed in Korean adolescents compared to adults [5], and lower intakes of fruits, vegetables, and milk were also reported in Korean adolescents with higher stress levels [32]. In the case of middle school students, a higher ratio of family meal frequency was shown to be related to higher intake frequencies of vegetables, fish, seaweeds, and milk, lower loneliness, lower anger, less lethargy, and better quality of life [33]. In this study, high milk intake frequency showed positive

correlations with total agreeability, organization, responsibility, conscientiousness, and intellectual curiosity only in boys. As the lack of correlation observed in girls is difficult to explain, additional studies should be conducted on the relationship between milk consumption and personality in the future. The limitations of this study are that two surveys were conducted on the same students with time lag. In 2011, only consumption frequencies of milk and milk products were determined. In addition, in 2011, general characteristics of the subjects were not investigated.

More diverse and extensive surveys on the relationship between milk consumption in adolescents and learning strategy and personality should be carefully conducted by considering gender differences.

In conclusion, milk consumption in Korean adolescents is related to academic performance, learning motivation and strategy, and personality, although it is somewhat limited. These results could be widely used to provide nutrition education materials for milk consumption and for the intellectual and emotional development of adolescents in the future.

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