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Analysis of factors related to early adolescent health

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We examined factors related to early adolescent health using the method of structural equation modeling. The study utilized self-administered questionnaire responses from 4,063 pairs of caregivers and their eighth-grade children taken from the "Child Living Conditions Survey" conducted by the local government in the Kanto region of Japan. The motivation of early adolescents to learn was strongly influenced by the educational investments made by their households. The responsive caregiver attitude contributed to the establishment of a rhythm of life and the enhancement of physical and mental well-being. The characteristic feelings of anxiety and loneliness during adolescence encouraged media use, which had a significant impact on worsening the child's physical condition, and increased consumption of sweetened beverages. Households had an important influence on restricting media use. We found that the child's household situation had a significant influence on whether the child had dental caries. Regardless of their household economic situation or dental health, they experienced an increase in motivation to learn and improved physical health through interactions at school. We think that it is necessary to further investigate adolescent-specific characteristics and the household economic situation which both impact the child's total health. (J Osaka Dent Univ 2024; 58: 241-252)

Key words: Early adolescent; Socioeconomic status; Health support

INTRODUCTION

Adolescence is considered the second period of rapid growth, during which the body and brain undergo simultaneous changes, cooperating in development. These changes in brain circuits serve as the foundation for feelings of personal growth desires, the establishment of goals, and motivation for social interactions.[1] As such, because this is a period of physical, social, emotional, and cognitive development, habits formed during this time often persist into adulthood. Furthermore, socioeconomic factors during the developmental process may potentially have long-term effects on health and behavior.[2]

Sleep-wake rhythms during adolescence are biologically different from those of adulthood, making it more difficult for youth to wake up. Their rhythm of life is more prone to disruption.[3] The brain is influenced by sex hormones, which can amplify negative emotions, leading to anxiety and loneliness.[4] In addition to these factors, in highly digitalized societies, media use has begun to increase significantly from about the age of 14.[5] Prior dental-related research has pointed to a connection between media use and the consumption of sweetened beverages.[6] Furthermore, the duration of difficult periods in the family's living conditions has been reported to be related to dental caries.[7] These findings suggest that a supportive family environment and corresponding health support are crucial for physical and mental growth, and for the changes that take place

during adolescence. However, despite the importance of this period, it is often perceived as temporary, and relatively few studies have investigated the distinctive habits and behaviors of adolescents in relation to their health and household situation.

Therefore, we hypothesize that family circumstances influence the characteristic feelings of anxiety and loneliness, media use, and rhythm of life in early adolescents, which in turn affect their health. In this study, we examined the relationships between household situations, health, and the unique habits and behaviors of early adolescents.

MATERIALS AND METHODS

Subjects of this study

We utilized data from the "Child Living Conditions Survey" conducted by local governments in the Kanto region of Japan in 2017, which assessed children's living conditions. The survey was conducted in public junior high schools selected by the local government and targeted eight-grade students and their caregivers who participated in the survey using questionnaires distributed through the schools. The self-administered questionnaires were divided into sections for caregivers and students to respond to, and responses that could be identified as coming from the same household were the subject of analysis.

Items of study

Household situation

The household socioeconomic situation was assessed using subjective living situation (ranging from "difficult" to "adequate" on a 5-point scale), unpaid bills for daily life (ranging from 0 to 4), years of education of parents (ranging from 9 to 16 years), annual income (categorized into 11 groups from "0" to "over 10 million yen"), weekly attendance at cram schools (ranging from "0" to "3 hours"), weekly attendance of lessons (ranging from "0" to "3 hours"), and monthly educational expenses (categorized into seven groups from "less than 20,000 yen" to "up to 140,000 yen"). Caregiver attitudes were assessed using a 4-item scale that measured how often a caregiver praised the child, listened to their feelings and stories, and worked together to explore them (ranging from "never" to "daily" on a 4-point scale). Dietary habits were evaluated by assessing the frequency of consumption of carbohydrates, proteins, and vegetables (ranging from "never" to "daily" on a 4-point scale). Additionally, the frequency of consumption of sweetened beverages, sweets as meals, and sweets (ranging from "never" to "daily" on a 4-point scale) were also considered.

Lifestyle

Breakfast meal (ranging from "none" to "daily" on a 4-point scale) and brushing teeth (ranging from "never" to "always," on a 4-point scale) were assessed. Time spent per day on the internet and social networking sites (ranging from "0" to "3 hours") and the frequency of talking to online friends (ranging from "never" to "frequent," on a 4-point scale) were also considered. An anxiety and loneliness score (ranging from 2 to 6 points) was used.

Health

For physical well-being, subjective health (ranging from "unhealthy" to "healthy" on a 4-point scale), sleep hours (ranging from 5 to 8 hours), and a score for physical fatigue (ranging from 3 to 9 points) were utilized. Regarding psychological aspects, scores for feeling loved by the family (ranging from 2 to 6 points), feeling accepted by friends and teachers (ranging from 2 to 6 points), and sense of coherence in personal life (ranging from 3 to 9 points) were employed. Furthermore, for social aspects, factors included enjoying school life (ranging from "never" to "very much" on a 4-point scale), frequency of talking to friends and teachers (ranging from "never" to "very much" on a 4-point scale). In terms of learning-related aspects, variables encompassed study hours per day (ranging from "0" to "3 hours"), the amount of effort being put into studying (ranging from 0 to 4), the desired years of education (ranging from 9 to 16 years), and preparation for school lessons (ranging from "never" to "very much" on a 4-point scale). All these items were assessed, and a higher score indicated a

stronger presence of the corresponding situation or characteristic.

Life class

The local government conducting the survey used a classification system based on two elements: disposable income below the poverty line, as defined by the Organisation for Economic Co-operation and Development (OECD), and payments for lifelines required for daily life. This classification divided participating households into three categories: a non-difficult class, a middle class and a difficult class.

Dental caries

The adolescents were asked whether they had dental caries. There were three possible responses, "No," "Yes" or "Not sure."

Method of analysis

Basic statistics

The differences in mean values of the items used were analyzed using *t*-tests based on gender. Differences in mean values among the life class categories were analyzed using one-way analysis of variance. Furthermore, for early adolescents who responded "Yes" or "Not sure" to having dental caries, the difference in the means between the non-difficult class and the group combining the middle class and difficult class were analyzed using the *t*-test. As the number of respondents in the "Yes" to carious teeth category was limited, "Yes" and "Not sure" responses were combined, and the analysis was conducted by combining the middle class and difficult class. The significance level in the analysis was set at 5%.

Multivariate analysis

In constructing the model, three domains were assumed: household situation, lifestyle, and health. The health domain referred to Kimura's Well-Being Scale, which encompassed physical, psychological, social aspects, and the capacity to create one's future.[8] Factors within these domains were extracted using exploratory factor analysis with the maximum likelihood method and promax rotation. The framework for the structural equation modeling used Kondo's suggested pathways from socioeconomic factors to health conditions.[9] The model was developed while confirming the direction of paths and the strength of their influence. Furthermore, the multi-group analysis was conducted to investigate the differences by gender and life class. We also studied the differences between the non-difficult class and the combined middle and difficult class groups among those who responded "Yes" or "Not sure" to having dental caries.

Goodness-of-fit indicators used for the model included GFI, AGFI, and RMSEA. GFI and AGFI were both considered good if they were above 0.9, and RMSEA was considered good if it was below 0.05.[10] In the analysis, ordinal scales based on a 4- to 5-point scale were treated as continuous variables. The model found all path coefficients to be statistically significant at the 5% level. All path coefficients were presented as standardized estimates. SPSS28.0 (IBM, Japan) and Amos28.0 (IBM, New York) were used for statistical analyses.

RESULTS

Summary of subjects

Out of a total of 6,429 datasets from eighth-grade junior high school students and their caregivers, we used data from 4,063 sets that had no missing values. Among the children, 1,927 were boys (47.4%) and 2,136 girls (52.6%), while among the caregivers, 3,822 were mothers (94.1%), 227 fathers (5.6%), and 6 grandmothers/siblings (0.1%), with 8 others (0.2%).

Comparison by gender

Girls had significantly more feelings of anxiety and loneliness than boys ($p < 0.001$), while boys had a significantly higher frequency of consuming sweetened beverages compared to girls ($p < 0.001$) (Table 1).

Comparison by life class of all subjects

The non-difficult class consisted of 2,679 individuals (65.9%); the middle class included 980 individuals (24.1%), and the difficult class comprised 404

Table 1 Relation of each item to gender, life class, and life class associated with dental caries

				Gender	
			Total $n=4,063$	$n=4,063$	
				Boys	Girls
				$n=1,927$ (47.4%)	$n=2,136$ (52.6%)
	Minimum	Maximum	Mean (SD)	Mean (SD)	Mean (SD)
Household situations					
Subjective living situation	1. difficult	5. adequqte	2.6 (0.9)	2.6 (0.9)	2.6 (0.9)
Unpaid bills for daily life	0	4	0.3 (1.0)	0.2 (1.0)	0.3 (1.1)
Years of education	9	16	13.9 (2.0)	13.9 (0.9)	13.9 (0.9)
Annual income	1. 0	11. 10 million yen	6.9 (2.2)	6.9 (2.3)	6.9 (2.3)
Attendance of cram school	0	3 hours	0.8 (0.7)	0.8 (0.9)	0.7 (0.9)
Attendance of lessons	0	3 hours	0.7 (0.9)	0.7 (0.9)	0.7 (0.8)
Monthly educational expenses	1. 20,000 yen	7. 140,000 yen	2.9 (1.8)	2.9 (1.8)	2.9 (1.8)
Child praised	1.never	4. daily	2.7 (0.8)	2.6 (0.8)	2.7 (0.8)
Listened to the child's feelings and stories	1. never	4. daily	3.1 (0.8)	3.0 (0.8)	3.2 (0.8)
Work together to explore	1. never	4. daily	2.2 (0.8)	2.1 (0.8)	2.2 (0.8)
Carbohydrates	1. never	4. daily	4.0 (0.2)	3.9 (0.2)	3.9 (0.2)
Proteins	1. never	4. daily	3.8 (0.4)	3.8 (0.4)	3.8 (0.4)
Vegetables	1 .never	4. daily	3.5 (0.7)	3.4 (0.8)	3.5 (0.7)
Sweetened beverages	1. never	4. daily	2.6 (1.0)	2.8 (1.0)	2.4 (1.0)
Sweets as meal	1. never	4. daily	1.3 (0.7)	1.2 (0.7)	1.2 (0.7)
Sweets	1. never	4. daily	2.9 (0.9)	2.8 (0.9)	2.8 (0.9)
Life style					
Has Breakfast	1. none	4. daily	3.8 (0.6)	3.7 (0.6)	3.8 (0.5)
Brushing teeth	1. never	4. always	3.1 (0.7)	3.0 (0.6)	3.1 (0.7)
Time spent per day on internet and social networking sites	0	3 hours	1.3 (0.9)	1.3 (0.9)	1.2 (0.9)
Talk to online friends	1. never	4. frequent	1.4 (0.8)	1.4 (0.7)	1.4 (0.8)
Anxiety/Loneliness	2	6	3.7 (1.3)	3.6 (1.3)	3.9 (1.3)
Health					
Subjective health	1. unhealthy	4. healthy	3.6 (0.6)	3.6 (0.6)	3.5 (0.7)
Sleep hours	5 hours	8 hours	6.5 (0.9)	6.5 (0.9)	6.4 (0.7)
Physical fatigue	3	9	5.8 (1.5)	5.7 (1.5)	5.9 (1.5)
Feeling loved by the family	2	6	5.3 (1.0)	5.3 (1.0)	5.3 (1.0)
Feeling accepted by friends and teachers	2	6	4.2 (1.1)	4.3 (1.1)	4.2 (1.1)
Sense of coheranse in personal life	3	9	6.6 (1.6)	6.8 (1.6)	6.5 (1.6)
Enjoying school life	1. never	4. very much	3.1 (0.8)	3.1 (0.8)	3.1 (0.8)
Talk to friends	1. never	4. very much	3.6 (0.7)	3.5 (0.7)	3.6 (0.6)
Talk to teachers	1. never	4. very much	2.7 (0.7)	2.7 (0.7)	2.7 (0.7)
Study hours per day	0	3 hours	1.0 (0.5)	1.0 (0.5)	1.1 (0.5)
Effort put into studying	0	4	1.8 (0.9)	1.7 (0.7)	1.9 (0.9)
Desired years of education	9	16	14.1 (1.5)	14.2 (1.6)	14.1 (1.5)
Preparation for school lessons	1. never	4. very much	3.4 (0.6)	3.3 (0.6)	3.5 (0.6)

	Life class $n=4,063$				Life class associated with dental caries Asked if they had caries Answered "Yes" or "Not sure" $n=928$		
	Non-difficut	Medium Difficult					
t-test *p* value	$n=2,679$ (65.9%) Mean (SD)	$n=980$ (24.1%) Mean (SD)	$n=404$ (9.9%) Mean (SD)	One-way analysis of variance	Non-difficut $n=550$ Mean (SD)	Medium/ Difficult $n=378$ Mean (SD)	*t*-test *p* value
0.194	2.8 (0.8)	2.3 (0.9)	1.9 (0.8)	<0.001	2.8 (0.9)	2.0 (0.9)	<0.001
0.376	0.1 (0.6)	0.3 (1.0)	1.4 (2.0)	<0.001	0.2 (0.7)	1.0 (1.8)	<0.001
0.659	14.2(1.9)	13.4 (0.9)	13.0 (1.8)	<0.001	14.0 (2.0)	13.1 (1.9)	<0.001
0.676	8.1 (1.7)	5.2 (0.9)	3.3 (0.9)	<0.001	8.1 (1.8)	4.5 (1.3)	<0.001
0.465	0.9 (0.9)	0.7 (0.9)	0.5 (0.8)	<0.001	0.8 (0.6)	0.6 (0.9)	<0.001
0.482	0.8 (0.9)	0.6 (0.8)	0.5 (0.8)	<0.001	0.7 (0.9)	0.6 (0.9)	0.003
0.475	3.1 (1.8)	2.7 (1.7)	2.3 (1.5)	<0.001	3.1 (1.8)	2.5 (1.6)	<0.001
<0.001	2.6 (0.8)	2.7 (0.8)	2.7 (0.8)	0.055	2.7 (0.8)	2.6 (0.8)	0.007
<0.001	3.2 (0.8)	3.1 (0.8)	3.0 (0.8)	<0.001	3.1 (0.8)	3.0 (0.8)	0.049
<0.001	2.1 (0.8)	2.2 (0.8)	2.2 (0.9)	0.399	2.2 (0.8)	2.2 (0.8)	0.491
0.060	4.0 (0.2)	4.0 (0.2)	3.9 (0.3)	<0.001	4.0 (0.2)	3.9 (0.3)	0.014
<0.001	3.9 (0.4)	3.8 (0.4)	3.7 (0.5)	<0.001	3.8 (0.4)	3.7 (0.5)	0.001
0.007	3.6 (0.7)	3.4 (0.8)	3.4 (0.9)	<0.001	3.5 (0.8)	3.4 (0.8)	0.100
<0.001	2.6 (1.0)	2.7 (1.0)	2.8 (1.0)	<0.001	2.7 (1.0)	2.8 (1.0)	0.198
0.351	1.2 (0.6)	1.3 (0.7)	1.4 (0.8)	<0.001	1.3 (0.6)	1.5 (0.8)	<0.001
0.108	2.9 (0.9)	2.9 (1.0)	2.7 (0.9)	0.005	2.9 (0.8)	2.8 (0.9)	0.048
0.034	3.9 (0.5)	3.8 (0.6)	3.7 (0.7)	<0.001	3.8 (0.6)	3.7 (0.7)	0.014
<0.001	3.2 (0.7)	3.1 (0.7)	3.0 (0.8)	<0.001	3.1 (0.7)	2.9 (0.8)	0.003
0.148	1.3 (0.9)	1.4 (0.9)	1.5 (1.0)	<0.001	1.4 (0.9)	1.5 (1.0)	0.102
0.798	1.4 (0.8)	1.4 (0.7)	1.5 (0.8)	0.009	1.5 (0.8)	1.6 (0.9)	0.122
<0.001	3.7 (1.3)	3.7 (1.3)	3.9 (1.3)	0.002	3.8 (1.3)	4.0 (1.3)	0.039
0.001	3.6 (0.6)	3.6 (0.6)	3.5 (0.7)	0.007	3.5 (0.7)	3.4 (0.7)	0.048
<0.001	6.5 (0.8)	6.5 (0.9)	6.5 (0.9)	0.507	6.3 (0.8)	6.4 (0.9)	0.227
<0.001	5.8 (1.5)	5.8 (1.5)	6.0 (1.5)	0.042	6.0 (1.5)	6.2 (1.6)	0.004
0.088	5.3 (1.0)	5.2 (1.0)	5.2 (1.1)	0.050	5.2 (1.1)	5.1 (1.1)	0.417
0.315	4.3 (1.1)	4.2 (1.1)	4.1 (1.2)	<0.001	4.1 (1.1)	4.0 (1.1)	0.224
<0.001	6.7 (1.6)	6.6 (1.6)	6.5 (1.8)	0.003	6.5 (1.7)	6.3 (1.6)	0.006
0.232	3.1 (0.8)	3.0 (0.8)	3.0 (0.9)	0.055	3.0 (0.9)	2.9 (0.9)	0.215
<0.001	3.6 (0.7)	3.5 (0.7)	3.5 (0.7)	0.418	3.6 (0.7)	3.5 (0.7)	0.152
0.181	2.7 (0.7)	2.7 (0.7)	2.7 (0.7)	0.402	2.7 (0.7)	2.7 (0.7)	0.336
<0.001	1.1 (0.5)	1.0 (0.5)	0.9 (0.5)	<0.001	1.0 (0.5)	0.9 (0.5)	0.005
<0.001	1.8 (0.9)	1.7 (0.9)	1.7 (0.9)	<0.001	1.8 (0.9)	1.7 (0.9)	0.103
0.024	14.3(1.5)	13.8 (1.5)	13.8 (1.5)	0.024	14.0 (1.5)	13.7 (1.4)	0.003
<0.001	3.4 (0.6)	3.4 (0.6)	3.3 (0.4)	0.023	3.4 (0.6)	3.2 (0.6)	0.005

individuals (9.9%). The middle and difficult classes had significantly lower percentages of caregivers listening to and understanding the child's feelings compared to the non-difficult class ($p < 0.001$ and $p < 0.001$, respectively) (Table 1).

Comparison by life class of early adolescents who responded "Yes" or "Not sure" to having dental caries

Among those who were asked if they had carious teeth, 3,135 individuals (77.2%) answered "No"; 272 (6.7%) answered "Yes," and 656 (16.1%) answered "Not sure." Among the 928 individuals who answered "Yes" or "Not sure," 550 were from the non-difficult class; 243 were from the middle class, and 135 were from the difficult class. The combined group of middle class and difficult class (378 individuals) had significantly more physical fatigue ($p = 0.004$) and a lower sense of coherence in personal life ($p = 0.006$) compared to the non-difficult class (550 individuals) (Table 1).

Structural equation modeling

Extraction of factors by exploratory factor analysis

In the factor analysis of the 16 items related to household situation, five factors were extracted, and factors with factor loadings above 0.29 after rotation were selected. The first factor was labeled "responsive caregiving attitude", the second factor was "household economic situation", the third factor was "nutrition", the fourth factor was "educational investment", and the fifth factor was "sweetened beverages and sweets" (Table 2). For the five items related to lifestyle habits and anxiety and loneliness, two factors were extracted. The first factor

Table 2 Results of factor analysis of household situation

Item	Factor				
	Ⅰ1st factor Resposibe caregiving attitude	Ⅱ2nd factor Household econoic situation	Ⅲ3rd factor Nutrition	Ⅳ4th factor Educational investment	Ⅴ5th factor Sweetened beverages and sweets
Praised the chird	0.780	0.007	0.003	0.006	0.002
Listen to the child's feelings and stories	0.661	0.000	0.030	0.009	−0.055
Work together to explore	0.618	0.140	0.028	0.012	0.061
Subjective living situation	0.008	0.824	0.044	0.177	0.032
Annual income	0.006	0.568	0.006	0.234	−0.004
Lifeline payment difficulties	0.028	−0.390	−0.062	0.002	−0.028
Years of education	0.012	0.293	0.050	0.107	−0.084
Proteins	0.014	0.021	0.787	0.010	0.067
Vegetables	0.033	0.026	0.561	0.005	−0.076
Carbohydrates	−0.017	0.035	0.375	−0.024	0.025
Monthly educational expenses	−0.012	0.009	0.008	0.562	−0.031
Attendance of cram school	−0.021	0.039	0.066	0.443	0.044
Attendance of lessons	0.032	0.054	0.006	0.385	0.043
Sweetened beverages	0.013	−0.017	0.020	0.034	0.574
Sweets	−0.009	0.080	0.086	0.019	0.386
Sweets as meal	0.016	−0.075	−0.123	0.002	0.337
Factor correlation matrix	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
Ⅰ	−	0.117	0.216	0.062	−0.050
Ⅱ		−	0.219	0.405	−0.161
Ⅲ			−	0.205	−0.181
Ⅳ				−	−0.068
Ⅴ					−

Factor loadings after rotation were set above 0.29.

was named "media use", and the second factor "rhythm of life." The "anxiety and loneliness" factor, which did not show a sufficient factor loading, was used as an observed variable (Table 3). In the 13 items related to health, three factors were extracted. The first factor, comprising six items related to behavior and psychology, was split into two latent variables, with behavior labeled as "interaction at school", and psychology as "mental well-being." The second factor was named "physical condition," and the third factor was "motivation to learn" (Table 4).

Table 3 Results of factor analysis of lifestyle

Item	Factor Ⅰ 1st factor Media use	Factor Ⅱ 2nd fctor Rhythm of life
Talking to online friends	0.701	0.049
Time spent per day on the internet and social networking sites	0.336	−0.129
Having breakfast	−0.017	0.632
Brushing teeth	−0.060	0.313
(Anxiety/Loneliness)	(−0.186)	(−0.048)
Factor correlation matrix	Ⅰ	Ⅱ
Ⅰ	−	−0.228
Ⅱ		−

Factor loadings after rotation were set above 0.29.

Construction of the model

Based on the results of the factor analysis mentioned above, a conceptual framework was assumed with the concepts of "rhythm of life," "media use," and "anxiety and loneliness" to draw a path diagram between household situations and health and create a model of household situations, lifestyle, and health (Fig. 1). The goodness-of-fit indices for the obtained model were as follows: GFI = 0.955, AGFI = 0.946, and RMSEA = 0.037. Based on these values, it was determined that the model was generally valid.

In the model, no significant direct paths from the household economic situation to the health of the early adolescents were observed. The household economic situation had an impact on educational

Table 4 Results of factor analysis of health

Item	Factor Ⅰ 1st factor ①Mental well-being ②Interaction at school	Factor Ⅱ 2nd factor Physical condition	Factor Ⅲ 3rd factor Motivation to learn
①Sense of coherence in personal life	0.736	0.099	0.001
①Feeling accepted by friends and teachers	0.695	0.045	0.030
①Feeling loved by the family	0.524	0.159	0.079
②Talks with teachers	0.492	−0.224	0.033
②Talks with friends	0.490	−0.220	0.012
②Enjoys school life	0.443	0.149	0.012
Physical fatigue	0.252	−0.653	−0.123
Sleep hours	−0.087	0.498	−0.115
Subjective health	0.171	0.412	−0.020
Study hours per day	0.010	−0.108	0.498
Effort put into studying	0.183	−0.049	0.317
Desired years of education	−0.062	0.057	0.298
Preparation for school lessons	0.094	0.134	0.290
Factor correlation matrix	Ⅰ	Ⅱ	Ⅲ
Ⅰ	−	0.608	0.468
Ⅱ		−	0.382
Ⅲ			−

Factor loadings after rotation were set above 0.29. The first factor is split into two latent variables, the behavioral variable and the psychological variable.

investment (β＝0.45), and subsequently, it strongly influenced the motivation of the adolescents to learn (β＝0.50). We also found that it had a significant positive impact on nutrition (β＝0.21) and responsive caregiver attitudes (β＝0.14). Nutrition and responsive caregiver attitude enhanced the rhythm of life (β＝0.30 and β＝0.21, respectively). The rhythm of life had a significant positive impact on physical condition and mental well-being (β＝0.26 and β＝0.17, respectively). We found no significant paths to anxiety and loneliness from any of the factors observed. Anxiety and loneliness significantly affected media use (β＝0.14) and the deterioration of physical condition and mental well-being (β＝−0.31 and β＝−0.20, respectively). Media use was found to have a significant impact on decreased motivation to learn (β＝−0.44), worsening physical condition (β＝−0.55), deteriorating rhythm of life (β＝−0.41), and increased consumption of sweetened beverages and sweets (β＝0.35). While the household economic situation exerted an influence on restricting media use (β＝−0.26). Within the four latent variables in the health domain, mental well-being promoted interactions at school, which in turn had a significant positive impact on physical condition and motivation to learn (β＝0.69 and β＝0.54, respectively) (Fig. 1).

Multigroup analysis

The goodness of fit of the models for boys, girls, the non-difficult class, and the middle class was judged to be generally valid. The model for the combined group of middle and difficult classes who responded “Yes” or “Not sure,” had an AGFI of less than 0.9. However, as the RMSEA was less than 0.05, a compromise was deemed possible, and the analysis was performed. By gender, the path coefficients from anxiety and loneliness to media use, physical condition, and mental well-being were significantly higher for girls (0.22, −0.31, −0.31, respectively) compared to boys (0.10, −0.25, −0.12, respectively) in a pairwise comparison. The influence of media use on motivation to learn and sweetened beverages and sweets was significantly higher for boys (−0.47 and 0.41, respectively) than for girls (−0.39 and 0.28, respectively) (Fig. 2). By

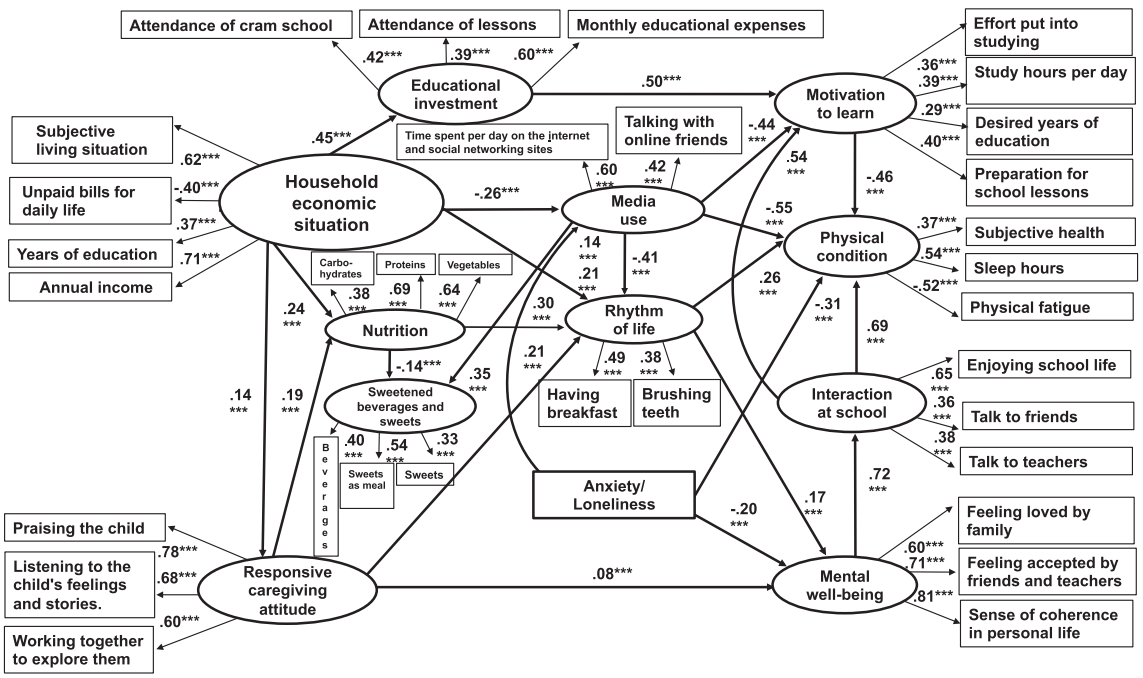

Fig. 1 Model related to household situation, lifestyle, and health. The goodness-of-fit indices for the model are GFI＝0.955, AGFI＝0.946, and RMSEA＝0.037. Numerical values in figures are overall standardized coefficients (n＝4,063, ***p＜0.001, **p＜0.01, *p＜0.05).

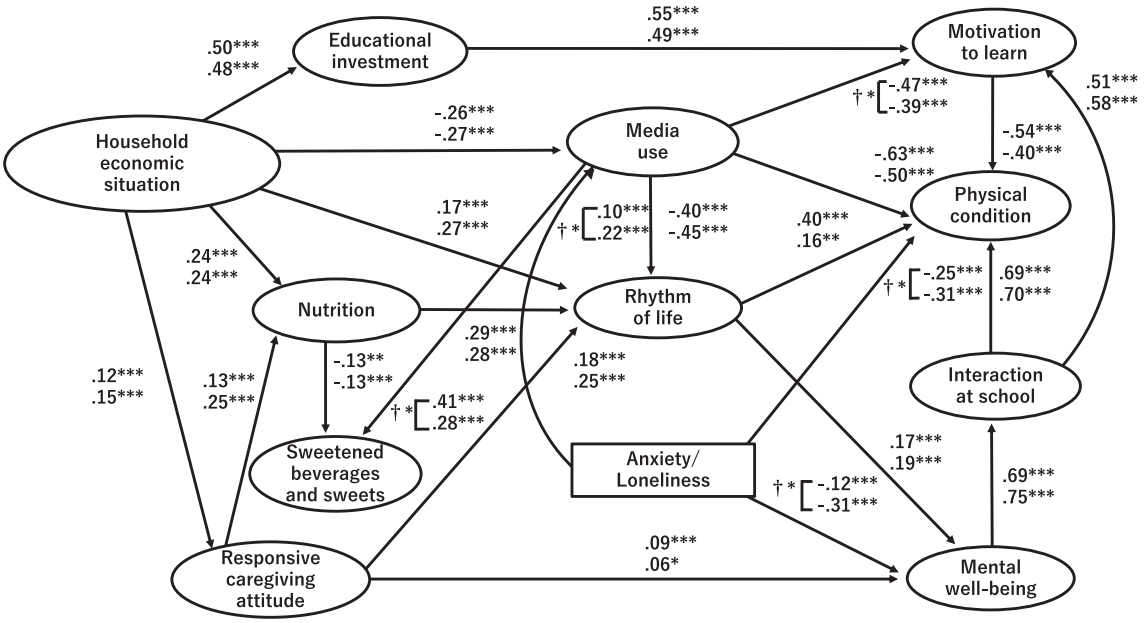

Fig. 2 Model related to household situation, lifestyle, and health by gender. The goodness-of-fit indices for the model in the multigroup analysis by gender are GFI＝0.947, AGFI＝0.937, and RMSEA＝0.026. Figures in the numerical values upper panel are standardized coefficients for boys (n＝1,927). Figures in the numerical values lower panel are standardized coefficients for girls (n＝2,136). (***p＜0.001, **p＜0.01, *p＜0.05, †*pairwise comparison p＜0.05)

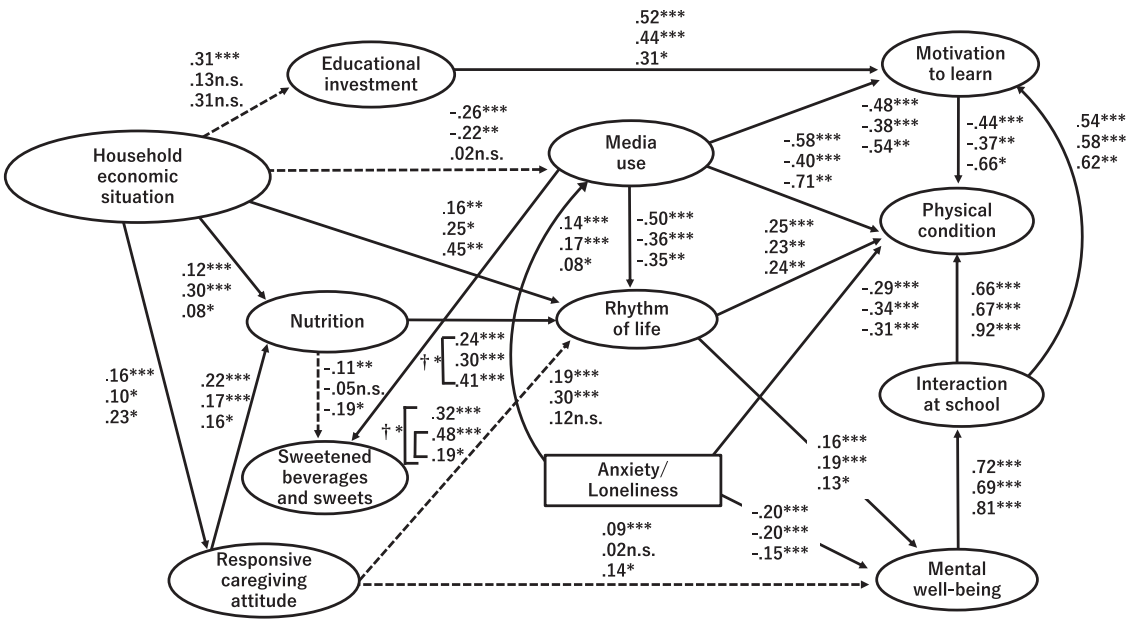

Fig. 3 Model related to household situation, lifestyle, and health by life class. The goodness-of-fit indices for the model in the multigroup analysis by life classes are GFI＝0.946, AGFI＝0.936, and RMSEA＝0.026 for the Non-difficult and Middle class, GFI＝0.946, AGFI＝0.936, and RMSEA＝0.026 for the Non-difficult and Difficult class, GFI＝0.926, AGFI＝0.912, and RMSEA＝0.025 for the Middle and Difficult class. Figures in the numerical values upper panel are standardized coefficients for the Non-difficult class (n＝2,679). Figures in the numerical values middle panel are standardized coefficients for the Middle class (n＝980). Figures in the numerical values lower panel are standardized coefficients for the Difficult class (n＝404, ***p＜0.001, **p＜0.01, *p＜0.05, †*pair-wise comparison p＜0.05).

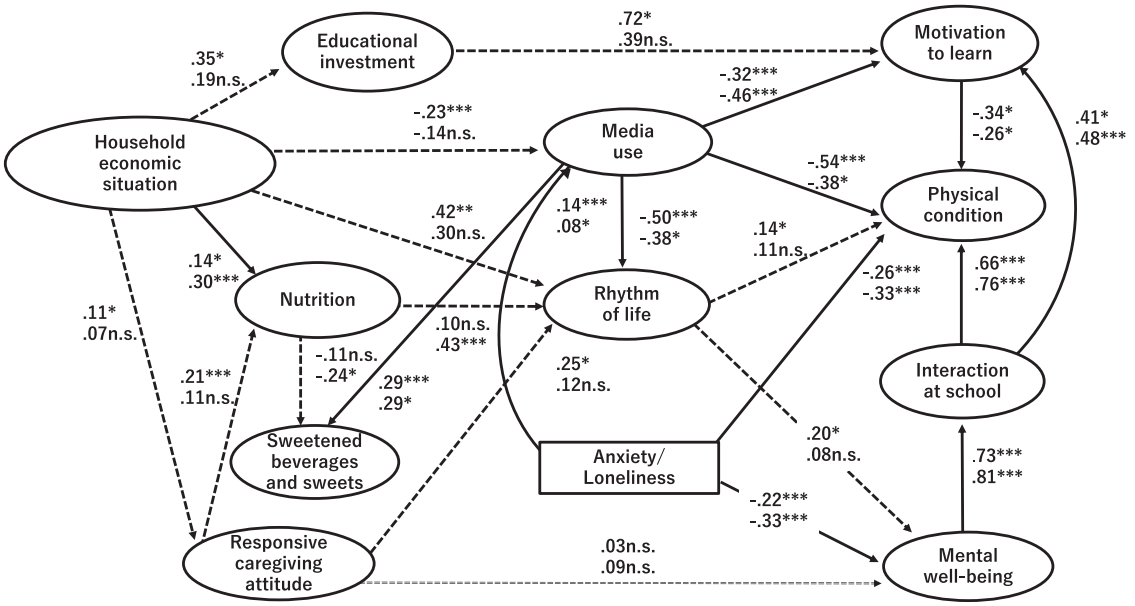

Fig. 4 Model related to household situation, lifestyle, and health by life class associated with dental caries. When asked if they had caries, they answered "Yes" or "Not sure." The goodness-of-fit indices for the model in the multigroup analysis by life class associated with dental caries are GFI＝0.909, AGFI＝0.893, and RMSEA＝0.026. Figures in the numerical values upper panel are standardized coefficients for the Non-Difficult class (n＝550). Figures in the numerical values lower panel are standardized coefficients for the Middle and Difficult classes (n＝378, ***p＜0.001, **p＜0.01, *p＜0.05, †*pair-wise comparison p＜0.05).

life class, the paths from household to educational investment, media use, and responsive caregiver attitudes to rhythm of life were not significant for the difficult class (Fig. 3). In the combined group of the middle class and the difficult class who responded "Yes" or "Not sure" to having carious teeth, many paths were not significant. They included the path from household economic situation to educational investment followed by motivation to learn, the path from responsive caregiver attitudes followed by physical condition, and the path to mental well-being (Fig. 4).

DISCUSSION

The characteristic feature of this study is how the household situation influences children's habits and behaviors in early adolescence, and how it acts on their health. This was charted using structural equation modeling to examine the relationship and strength of these factors. It has been reported that the higher the household income and the more years of education a child's caregiver expects the child to receive, the greater the family's investment in education and the greater the opportunity for the child to receive education.[11] In the period leading up to the high school entrance exam, we also found that a good household economic situation had a strong influence on increasing the children's motivation to learn through educational investment. Nutrition and responsive caregiver attitudes influenced the rhythm of life and were associated with the body and mind. This suggests that, in addition to stable nutrition as a result of the household economic situation, responsiveness in caregiving attitude, such as listening, is a source of security for children in early adolescence in terms of their emotional state; moreover, working together is a source of knowledge, skill acquisition, and socialization.[12] Therefore, it can be assumed that it is important for caregivers to respond to emotional events and have a guiding attitude.

The caregiver's actions affect the rhythm of life, enhance mental health, and raise the child's level of prosociality.[13] Furthermore, the household economic situation had an inhibitory effect on media use. It has been reported that the household's cul-

tural hierarchy inhibits prolonged internet use.[14] Therefore, it is assumed that the household's cultural capital, such as habits, preferences, and skills,[15] affects the child's perception of appropriate media use. The influence of media use is substantial; in addition to the regression in sleep rhythms, induction of fatigue, decreased motivation to learn, and disruption of the rhythm of life,[16] we found that it also involved an increase in the frequency of consumption of sweetened beverages and sweets. An increase in the frequency of consumption of sweets high in sugar and saturated fatty acids may lead to a decrease in the diet's overall quality. The dangers of increased intake of sweetened beverages should not be overlooked, and the fact that the effect was stronger in boys suggests that gender differences need to be considered when communicating this to adolescents and caregivers. Further, anxiety and loneliness have a negative influence on the physical and mental state and also encourage media use. This was found to be stronger among girls. Adolescent girls are said to suffer more from psychological and physical distress. The genders exhibit clear differences.[17] We believe more attention should be paid to the understanding of distress due to media use.

In the difficult class, no significant relationship was found between the household economic situation and higher educational investment or between caregiving attitudes and the child's rhythm of life. For children in the middle and difficult classes who reported "Yes" or "Not sure" to having caries, no significant relationship was found between educational expenditure on motivation to learn and the rhythm of life leading to better physical and mental well-being. Having caries is associated with a low level of financial support for learning from the household. This was confirmed in a report that found an association between lessons and missed dental examinations in primary school children.[18] Without the necessary financial resources in the household, it is more difficult for caregivers to respond to children with time and empathy,[19] which may be one of the reasons why caregiver attitudes were not identified as a factor enhancing children's rhythm of life. The fact that it has been pointed out that the dental caries of children in the low-income group is influenced by a poor psychological state of their caregivers[20] suggests that the economic situation may influence the child's dental health and health behaviors through the relationship between the caregivers and children. The fact that the early adolescents in the middle and difficult classes who answered "Yes" or "Not sure" to having caries had more complaints and less sense of coherence in personal life indicates that their physical and mental state may also be affected.

Regardless of life class and dental health, early adolescents' mental state was the starting point in their health, and through interaction with friends and teachers at school, their physical condition and motivation to learn are enhanced. Feeling accepted at school is said to increase self-esteem.[21] The results of the present study are consistent with those of previous studies showing that even when early adolescents are in a psychologically unstable state, their adaptability and resilience to overcome this through school life brings a sense of fulfilment and has a positive impact on their schoolwork.[22] Furthermore, such a sense of fulfilment is thought to enable early adolescents to adjust physically.

This study has some limitations. As it is a cross-sectional study, it is not possible to discuss relationships while taking into account changes over time. In addition, the analysis assumes that the child is the affected party and does not take into account aspects of their active involvement in the household, environment, or behavior. For more detailed research, it is necessary to look at children's behavior and health from the perspective of the mutual relationship between caregiver and child in the household, including children's perceptions of how they are treated at home and their ideas about health.

This study revealed that children in early adolescence are influenced by their household through their motivation to learn, habits, and health behaviors. Moreover, their motivation to learn and physical condition are enhanced through their interactions with friends and teachers at school. There-

fore, a responsive caregiver attitude is important in supporting the health of adolescents, and it is critical not to overlook the negative effects of media use. We think that it is necessary to further investigate adolescent-specific characteristics and the impact of the household economic situation on total health.

Ethics approval
This study was approved by the Medical Ethics Committee at Osaka Dental University (Dental Ethics No. 111239).

Conflicts of Interest
The authors declare no conflicts of interest associated with this study.

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