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Nutritional Health Status of Rural Adolescent in Kumbakonam Taluk, Tamil Nadu, India: A Path Application Model

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Abstract:
Background: Adolescents nutritional health status is having direct causal relationship with their family wealth, educational status of parents, type of food consumed/day, physical activity/day net calorie retained/day and body mass index.
Objectives: To measure the causal relationship between the variables of adolescent's wealth index, calorie consumed/day, calorie burnt/day, net calorie retained/day and body mass index.
Methods: In 2017, 2790 rural adolescents aged 13-19 years in Kumbakonam taluk, Tamil Nadu, India were selected by stratified random sampling procedure. Wealth index is measured by their family annual income, parent's occupational and educational status. Gross Calorie Consumed/Day (GCCD) is calculated by type of food consumed in past 24 hours. Calorie Burnt/Day (CBD) is measured by their usual physical activity/time spent/day. The subtraction of Calorie Consumed/Day (CCD) and Calorie Burnt/Day (CBD) is Net Calorie Retained/Day (NCRD). The Body Mass Index (BMI) is measured by weight (kg)/height (m^2). Hence, the underlying relationship of adolescent's health status is measured by above cited observed variables.
Results: Adolescent's family wealth is having direct causal relationship with their body mass index, net calorie consumed/day and calorie burnt/day. However, the variable net calorie consumed/day is having direct positive causal relationship with body mass index and direct negative causal relationship with calorie burnt/day. The body mass index and wealth of the family is having direct positive casual effect on health status of adolescents in rural areas of Kumbakonam Taluk in India. Therefore, the Structural Equation Model (SEM) of adolescent's health status data set suit with the fit indices and the proposed hypothesis model has acceptable fit by the recommended values.
Key Words: Adolescent health, Nutritional health, Health status, Structural Equation Model

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I. INTRODUCTION

Globally, 1.2 billions of adolescents and nearly 90.0 per cent lives in developing countries. More than 50.0 per cent of all adolescents live in Asia. India is home to large number of adolescents about 243 million.The phrase adolescence is derived from the Latin word 'adolescere'; meaning "to grow or to mature." This period of life is from 10 to 19 years and characterized by rapid physical, emotional and psychological growth. Growth during adolescence is faster. Good nutrition during adolescence is required to meet the demands of physical and cognitive growth and development. A large percentage of adolescents in India suffer from nutritional deficiencies. Dietary intake of food is with respect to adequate and availability in terms of quantity and quality (caloric intake). In 1996, 1975-79 and 200-2001 the National Nutrition Monitoring Bureau (NNMB-India) was conducted surveys and compared. The survey results revealed that the intake of all the nutrients was less than the Recommended Dietary Allowance (RDA-India) for all age groups and in both the sexes. The diets were grossly deficient in micronutrients such as iron and vitamin A. More than 80.0 per cent of adolescents are getting less than 50.0 per cent of their daily dietary requirements of vitamin A. Similarly, more than 70.0 per cent had their iron-deficient diet by more than 50.0 per cent of RDA and more than 50.0 per cent of boys and girls get less than 50.0 per cent of required calcium. Almost half of the adolescents of both sexes were not getting even 70.0 per cent of their daily requirements of energy and a quarter of them were getting less than 70.0 per cent of RDA of proteins. However, the extent of severe deficit with respect to energy intake (<50.0%) decreased from 21.0 to 9.0 per cent in boys and 14.0 to 5.0 per cent in girls during 1996-97 as compared to 1975-79.

Therefore, nutrients that adolescent obtain through food have vital effects on their physical growth and development, body function, physical activity and health. Nutritious food is needed to sustain life and activity. Diet must provide all essential nutrients in the required amounts. Requirements of essential nutrients vary with age, gender, physiological status and physical activity. Dietary intakes lower or higher than the body requirements can lead to under nutrition or over nutrition respectively. Eating too little food during adolescent periods and eating too much can lead to harmful consequences. With this background, the present study was undertaken with the objective to assess the nutritional health status of rural adolescent in Kumbakonam taluk and to measure the causal relationship between the variables of adolescent's wealth index, calorie consumed/day, calorie burnt/day, net calorie retained/day and body mass index using structural equation model. This study is helpful for dietary counselling by providing a reference for dietary modification to prevent under nutrition, overweight, obesity and associated risks.

II. OVERVIEW

Anthropometric measurement is sensitive indicator of health. It has been used during adolescence in many context related to nutritional status (WHO 1995; Bose and Mukhopadhyay et al. 2005; Gupta et al. 2011; Gaiki and Wagh 2014). The prevalence of malnutrition, particularly, among adolescents is an alarming global problem affecting about one third of the world population and the immediate future having no solution. In the long duration, this may affect both physical growth and mental development (Bagchi 1986). Many developing countries face an increasing burden of under nutrition (Mukhopadhyay et al. 2005; Dey et al. 2011; Kumar 2012). It is also a culminating of constraints in India (Popkin et al. 2001).

Path Analysis is a method that allows application of theoretical models to examine dependency relationships between variables (Kleinbaum D, et al 2013). A key feature of this method is its ability to examine direct and indirect effects between variables (Gamborg M, et al 2011). The results allow researchers to identify or hypothesize causal relationships between variables obtained in cross-sectional studies (Bielderman A, et al 2014; Howe LD, et al 2013).

III. METHODOLOGY

Study Area

Kumbakonam taluk is located in Thanjavur District and important religious places are located in this area. According to the 2011 census, this taluk had a population of 435,962 with 216, 186 males and 219,776 females. There were 1017 women for every 1000 men. The taluk had a literacy rate of 78.05. The total number of households was 91,470. All Panchayat (93) Villages in Kumbakonam Taluk is chosen for present study. This rural area is well known for its agricultural activities (Granary of Tamil Nadu).

Study Population

The questionnaire scheduled survey was carried out during the year 2016 and 2017 to examine the nutritional health status of adolescents (boys and girls) aged 13-19 years. 30 adolescents were selected from each (93) village by stratified random sampling, totally (93x30) 2790. Of which, 1395 (50.0%) and 1395 (50.0%) are boys and girls respectively. They are the respondents of the present study. The purpose of the study is to investigate the socio-economic condition, physiological status and dietary behaviour.

Data Analysis

Data collected were entered and analysed using SPSS and AMOS package. The Wealth index is measured by their family annual income, parent's occupational and educational status (Kumar, N et al 2007; Govt. of India 2007). Gross Calorie Consumed/Day (GCCD) is calculated by type of food consumed in past 24 hours. Calorie Burnt/Day (CBD) is measured by their usual physical activity spent (hours) in a day. The subtraction of Calorie Consumed/Day (CCD) with Calorie Burnt/Day (CBD) is Net Calorie Retained/Day (NCRD). The Body Mass Index (BMI) is measured by weight (kg)/height (m^2). Hence, the underlying relationship of adolescent's nutritional health status was measured by above cited observed variables.
The above mentioned observed and measured variables were used for path analysis. The results of Structural Equation Model (SEM) of adolescent's data set suit with the fit indices and the proposed hypothesis causal model relationships are acceptable fit by the recommended values.

IV. RESULTS

A total of 2790 adolescents participated in this study, 1395 (50.0%) were boys and 1395(50.0%) were girls. Their ages were from 13 to 19 years and mean age was 16 years. They are having very poor (<6, 2.8%), poor (7.0-9.0, 14.2%), moderate (10.0-12.0, 27.0%), good (13.0-15.0, 21.0%) and very good (>16.0, 34.9%) wealth index (Table 1).

Wealth Index (WI)

Sl. No.	Wealth Index	Frequency	Percentage	Categories
1	< 6.00	78	2.8	Very Poor
2	7.00-9.00	397	14.2	Poor
3	10.00-12.00	754	27.0	Moderate
4	13.00-15.00	587	21.0	Good
5	> 16.00	974	34.9	Very Good

Table 1

The table 2 shows that the respondents Gross Calorie Consumed/Day (GCCD) were <2000 (0.8%), 2001-3000 (12.1%), 3001-4000 (45.0%), 4001-5000 (34.2%) and >5000 (8.0%). Their Calorie (Table 3) Burnt/Day (CBD) were <200 (2.2%), 201-400 (28.2%), 401-600 (65.4%), 601-800 (4.0%) and >801 (0.3%).

Gross Calorie Consumed/Day (GCCD)

Sl. No.	Calorie Gain/Day	Frequency	Percentage	Categories
1	<2000	22	0.8	Very Poor
2	2001-3000	337	12.1	Poor
3	3001-4000	1255	45.0	Moderate
4	4001-5000	953	34.2	Good
5	>5001	223	8.0	Very Good

Table 2

Calorie Burnt/Day (CBD)

Sl. No.	Calorie loss/day	Frequency	Percentage	Categories
1	<200	60	2.2	Very Low
2	201-400	787	28.2	Low
3	401-600	1825	65.4	Medium
4	601-800	111	4.0	High
5	>801	7	0.3	Very High

Table 3

The adolescent's Net (Table 4) Calorie Retained/Day (NCRD) were <2000 (2.5%), 2001-3000 (20.6%), 3001-4000 (47.9%), 4001-5000 (27.0%) and >5000 (2.0%). According to Body Mass Index (Table 5) the adolescent in the region are having underweight (1.3%), Healthy weight (23.3%), over weight (52.5%), obese (21.2%), severely obese (1.5%) and morbidity obese (0.2%).

Net Calorie Retained/Day (NCRD)

Sl. No.	Total Calories Gain/Day	Frequency	Percentage	Categories
1	<2000	71	2.5	Very Poor
2	2001-3000	574	20.6	Poor
3	3001-4000	1337	47.9	Moderate
4	4001-5000	753	27.0	Good
5	>5001	55	2.0	Very Good

Table 4

Body Mass Index

Sl. No.	Body Mass Index	Frequency	Percentage	Categories
1	<18.50	37	1.3	Underweight
2	18.51-24.99	650	23.3	Healthy weight
3	25.00-29.99	1464	52.5	Overweight
4	30.00-34.99	592	21.2	Obese
5	35.00-39.99	42	1.5	Severely Obese
6	>40	5	0.2	Morbidity Obese

Table 5

As a result, the adolescent's health index (Table 6) were reveals that 18.1 (505), 80.0 (2233) and 1.9 (52) per cent are poor, good and very good health status respectively in the rural areas of Kumbakonam taluk.

Health Index

Sl. No.	Health Index	Frequency	Percentage	Categories
1	<4	505	18.1	Poor
2	5-7	2233	80.0	Good
3	>8	52	1.9	Very Good

Table 6

Hence, following constructs are made to test the hypothesis, to find out the significant causal relationship between the selected variables and whether the data set suit with the fit indices and the proposed model has acceptable fit by the recommended values using structural equation model.

V. DISCUSSION

Model fit assessment

Path Analysis with Structural equation modelling (SEM) Scalar estimates (group number 1 - default model)

Maximum Likelihood Estimates

Path analysis with structural equation modelling used to analyze the suitability of the model based upon the selected variables. As recommended by Anderson and Gerbing (1988), measurement model to test the reliability and validity of the survey instrument was analyzed first, and by using AMOS version 20 the path analysis model was analyzed. This path analysis with structural equation model (SEM) is the most useful while assessing the causal relationship between the variables as well as verifying the compatibility of the model used (Peter, 2011).

Structural equation modelling evaluates whether the data fit a theoretical model. As per the result, Chi square statistics with P = 0.627 is greater than recommended value (p=<0.05). Therefore, it does not show a good fit of the model. Nevertheless according to Joreskog and Sorbom (1993), a sample size of over 200 (2790 in this research), could affect Chi-Square statistics to indicate a significant probability level. Consequently, this model is considered for further interpretation in the goodness of fit measures (Barbara 2009). Common model-fit measures like chi-square/degree of freedom ($\chi 2$/df), the comparative fit index (CFI), root mean square error of approximation (RMSEA), the normated fit index (NFI), incremental fit index (IFI), and the Tucker Lewis index (TLI) were used to estimate the measurement model fit. Table-1 shows the estimates of the model fit indices from AMOS structural modelling.

Fit statistics of the Measurement model

Sl.No.	**Fit statistic**	**Recommended**	**Obtained**
1	Chi Square	-	0.237
2	df	-	1
3	Chi Square significance	P< =0.05	0.627
4	Chi Square ⁄df	<5.0	0.237
5	Goodness of Fit Index (GFI)	>0.9	1.000
6	Adjusted Goodness of Fit Index (AGFI)	>0.9	0.999
7	Normated Fit Index (NFI)	>0.9	1.000
8	Relative Fit Index **(**RFI)	>0.9	0.999
9	Comparative Fit index (CFI)	>0.9	1.000
10	Tucker Lewis Index (TLI)	>0.9	1.003
11	Incremental Fit Index (IFI)	Approaches 1	1.000
12	Root mean square error of approximation (RMSEA)	<0.05	0.001
13	Root Mean Square Residual (RMR)	<0.02	0.001
14	Parsimony goodness-of-fit index (PGFI)	<5.0	0.067

Table 7

According to Gerbing and Anderson (1992), the criteria for an acceptable model are as follows: RMSEA of 0.08 or lower; CFI of 0.90 or higher; and NFI of 0.90 or higher. The fit between the data and the proposed measurement model can be tested with a Chi-Square Goodness of Fit (GFI) test where the probability is greater than or equal to 0.9 indicating a good fit (Hu and Bentler, 1999). The GFI of this (Table 7) study was 1.000 more than the recommended value of 0.90 the other measures fitted satisfactorily; AGFI=0.999, RFI=0.999, CFI=1.000, TLI=1.003, IFI=1.000, NFI=1.000 with χ 2/df=0.237, RMSEA=0.001 (Bagozzi and Yi, 1988), RMR=0.001 and PGFI=0.067 indicate a good absolute fit of the model. Goodness of fit indices support the model fit and these emphasized indices indicate the acceptability of this structural model. For the purpose of testing the following hypothesis are framed.

Hypothesis

H_1: Wealth of family has significant effect on net calorie retained/day
H_2: Wealth of family has significant effect on body mass index
H_3: Wealth of family has significant effect on calorie burnt/day
H_4: Net calorie retained/day has significant effect on body mass index
H_5: Net calorie retained/day has significant effect on calorie burnt/day
H_6: Net calorie retained/day has significant effect on health status of adolescents
H_7: Wealth of family has significant effect on health status of adolescents
H_8: Calorie burnt/day has significant effect on health status of adolescents
H_9: Body mass index has significant effect on health status of adolescents

The test of above mentioned hypothesis, the SPSS-AMOS result provides nine regression weights, unstandardized and standardized factor model structures (Figure 1 and 2) for every path and its significance.

The table 8 is demonstrating the unstandardized coefficients and associated test statistics. The amount of change in the dependent or mediating variable for each unit change in the variable predicting it is symbolized by the unstandardized regression coefficient. The Table 7 also shows the standardized estimate, standard error (abbreviated S.E.), and the estimate divided by the standard error (abbreviated C.R. for Critical Ratio). Under the column P, the probability value associated with the null hypothesis is as exhibited.

The results of hypothesis testing for the respected paths are showing in the Table 9.

The Regression Weights for Every Path and Its Significance

Construct	Path	Construct	Unstandardized co-efficient	S.E.	Standardized co-efficient	Critical Ratio	P	Result
Net Calorie Retained/Day	<---	Wealth of Family	0.011	0.003	0.072	3.788	0.001**	Significant
Body Mass Index	<---	Wealth of Family	0.008	0.003	0.055	2.896	0.004**	Significant
Calorie Burnt/Day	<---	Wealth of Family	0.012	0.002	0.103	5.492	0.001**	Significant
Body Mass Index	<---	Net Calorie Retained/Day	0.092	0.018	0.098	5.183	0.001**	Significant
Calorie Burnt/Day	<---	Net Calorie Retained/Day	-0.104	0.013	-0.145	-7.750	0.001**	Significant
Health Status of Adolescents	<---	Net Calorie Retained/Day	0.012	0.014	0.010	.879	0.379	Not Significant
Health Status of Adolescents	<---	Wealth of Family	0.008	0.002	0.043	3.819	0.001**	Significant
Health Status of Adolescents	<---	Calorie Burnt/Day	0.026	0.019	0.016	1.367	0.172	Not Significant
Health Status of Adolescents	<---	Body Mass Index	1.021	0.014	0.801	70.942	0.001**	Significant

Table 8

**Indicate a highly significant at < 0.001

Level of Significance for Regression Weight

` The path coefficient of Wealth of Family to Net Calorie Retained/Day is 0.011. This value indicates that for every one unit increase in Wealth of Family; its effects would contribute 0.011 unit increase in Net

Calorie Retained/Day. The effects of Wealth of Family on Net Calorie Retained/Day is significant ($p<0.001$). Thus, the hypothesis (H_1) that Wealth of Family has significant and positive effects on Net Calorie Retained/Day is supported.

The Results of Hypothesis Testing for the Respected Path

Hypothesis of Path Analysis	Estimate	P-value	Results on Hypothesis
H_1	0.011	0.001**	Supported
H_2	0.008	0.004**	Supported
H_3	0.012	0.001**	Supported
H_4	0.092	0.001**	Supported
H_5	-0.104	0.001**	Supported
H_6	0.012	0.379	Not Supported
H_7	0.008	0.001**	Supported
H_8	0.026	0.172	Not Supported
H_9	1.021	0.001**	Supported

Table 9

. The path coefficient of Wealth of Family to Body Mass Index is 0.008. This value specifying that for every one unit increase in Wealth of Family; its effects would give 0.008 unit increase in Body Mass Index. The effects of Wealth of Family on Body Mass Index is significant ($p<0.001$). Therefore, the hypothesis (H_2) that Wealth of Family has significant and positive effects on Body Mass Index is supported.

The path coefficient of Wealth of Family to Calorie Burnt/Day is 0.012. This value denotes that for every one unit increase in Wealth of Family; its effects would provide 0.012 unit increase in Calorie Burnt/Day. The effects of Wealth of Family on Calorie Burnt/Day is significant ($p<0.001$). As a result, the hypothesis (H_3) that Wealth of Family has significant and positive effects on Calorie Burnt/Day is supported.

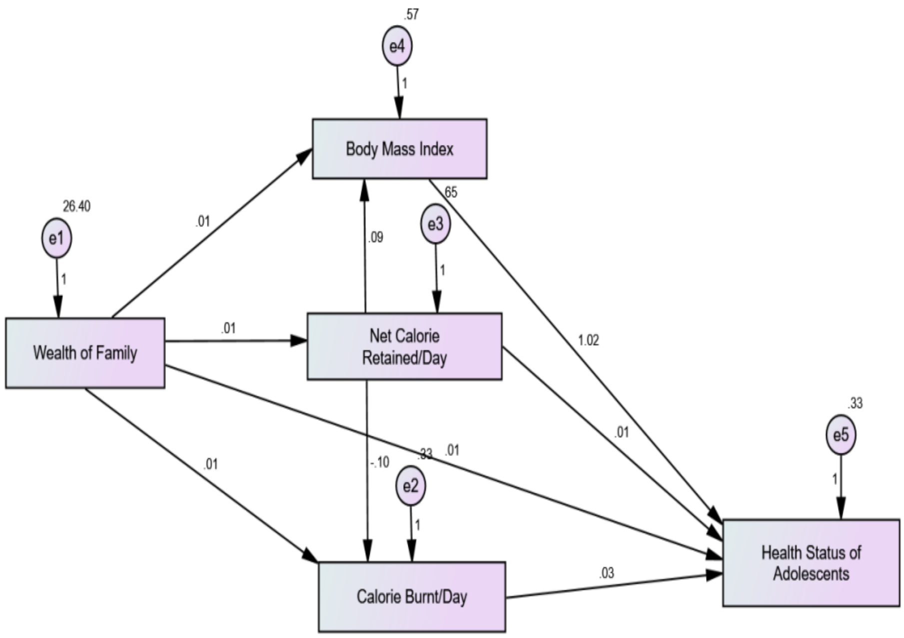

Figure-1Path Model on Health Status of Adolescent: Unstandardized Estimates

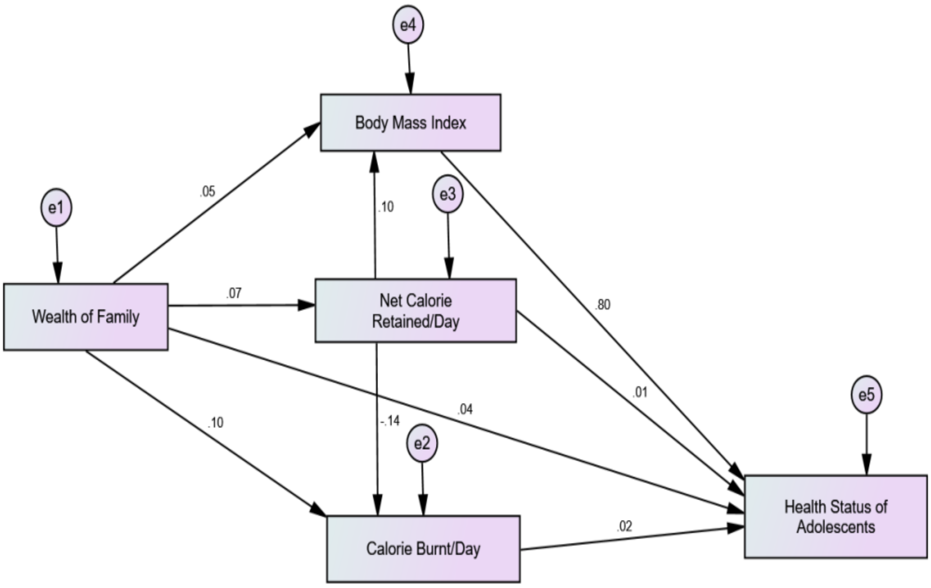

Figure-2 Path Model on Health Status of Adolescent: Standardized Estimates

The coefficient of Net Calorie Retained/Day to Body Mass Index is 0.092. This value indicates that for every one unit increase in Net Calorie Retained/Day; its effects would contribute 0.092 unit increase in Body Mass Index. The effects of Net Calorie Retained/Day on Body Mass Index is significant ($p<0.001$). As a result, the hypothesis (H_4) that Net Calorie Retained/Day has significant and positive effects on Body Mass Index is supported.

The coefficient of Net Calorie Retained/Day to Calorie Burnt/Day is -0.104. This value shows that for every one unit increase in Net Calorie Retained/Day; its effects would contribute -0.104 unit decrease in Calorie Burnt/Day. The effects of Net Calorie Retained/Day on Calorie Burnt/Day is significant ($p<0.001$). As a result, the hypothesis (H_5) that Net Calorie Retained/Day has significant and negative effects on Calorie Burnt/Day is supported.

The path coefficient of Net Calorie Retained/Day to Health Status of Adolescents is 0.012. This value demonstrates that for every one unit increase in Net Calorie Retained/Day; its effects would give 0.012 unit increase in Health Status of Adolescents. The effects of Net Calorie Retained/Day on Health Status of Adolescents is not significant because ($p=0.379$) the p value is greater than 0.05. As a result, the hypothesis (H_6) that Net Calorie Retained/Day has not significant and positive effects on Health Status of Adolescents is not supported.

The path coefficient of Wealth of Family to Health Status of Adolescents is 0.008. This value specifies that for every one unit increase in Wealth of Family; its effects would contribute 0.008 unit increase in Health Status of Adolescents. And more importantly, the effects of Wealth of Family on Health Status of Adolescents is significant ($p<0.001$). Thus, the hypothesis (H_7) that Wealth of Family has significant and positive effects on Health Status of Adolescents is supported.

The path coefficient of Calorie Burnt/Day to Health Status of Adolescents is 0.026. This value specifies that for every one unit increase in Calorie Burnt/Day; its effects would contribute 0.026 unit increase in Health Status of Adolescents. And more importantly, the effects of Calorie Burnt/Day on Health Status of Adolescents is not significant because ($p=0.172$) the p value is greater than 0.05.. Thus, the hypothesis (H_8) that Calorie Burnt/Day has not significant and positive effects on Health Status of Adolescents is not supported.

The path coefficient of Body Mass Index to Health Status of Adolescents is 1.021. This value indicates that for every one unit increase in Body Mass Index; its effects would contribute 1.021 unit increases in Health Status of Adolescents. And more importantly, the effects of Body Mass Index on Health Status of Adolescents is significant ($p<0.001$). Thus, the hypothesis (H_9) that Body Mass Index has significant and positive effects on Health Status of Adolescents is supported.

VI. CONCLUSION

The proposed path model is calibrated using the data collected from adolescent in Kumbakonam taluk, Thanjavur district of Tamil Nadu in India. The nutritional health status of adolescent scale used in this study is adequately fit into the collected data. This study concludes that the hypothesized nine hypothetical models fit the sample data. Based on the viability and statistical significance of essential parameter estimates, the good fit of the model represents an adequate description of adolescent health status goodness of fit indices support the model fit. Therefore, adolescent's family wealth, body mass index, net calorie retained/day and calorie burnt/day are controlling the health status of adolescent in this region.

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