

**Original Article:**

Prevalence and Patterns of Non-Communicable Disease Risk Factors in Adolescents: A South-Kerala School Based Study

Authors:

Babu George, Director (Former),

Deepa Bhaskaran, Director (IC),

Leena Mundappaliyil Leela, Senior Research Coordinator,

Jubyraraj Aswathymana Raju, Project Associate,

Lalikumari Indiradevi, Project Assistant,

Preema Mahendran, Project Assistant,

Neethu Thulaseedharan, Project Associate,

Child Development Centre, Government Medical College Campus, Thiruvananthapuram, Kerala, India.

Address for Correspondence

Leena Mundappaliyil Leela,

Senior Research Coordinator,

Child Development Centre,

Government Medical College Campus,

Thiruvananthapuram, Kerala, India.

E-mail: cdctvpmresearch@gmail.com.

Citation

George B, Bhaskaran D, Leela LM, Raju JA, Indiradevi L, Mahendran P, Thulaseedharan N. Prevalence and Patterns of Non-Communicable Disease Risk Factors in Adolescents: A South-Kerala School Based Study. *Online J Health Allied Scs.* 2025;24(1):1. Available at URL: <https://www.ojhas.org/issue93/2025-1-1.html>

Submitted: Jan 1, 2025; Accepted: Feb 22, 2025; Published: Apr 15, 2025

Abstract: Background: In the background of rising prevalence of non-communicable diseases (NCDs), the health system needs to implement preventive strategies particularly at early stages of disease development. Addressing these issues should commence in childhood, as unhealthy lifestyle practices play a significant role in influencing health outcomes from an early age. **Methods:** This cross sectional study was conducted among 1852 class eleven students in 15 Higher Secondary Schools in Thiruvananthapuram district selected through multistage cluster sampling. Dietary practices, physical activity and screen use patterns, substance abuse, and perceived stress levels were assessed using a prevalidated questionnaire. Blood Pressure, Anthropometric measurements, and Acanthosis nigricans neck severity grading were also recorded. **Results:** About 25% of the students had Grade I Hypertension and 8.3% had Grade II Hypertension. Around 19% of the students were overweight, while 6.4% were obese. Around 62% of the participants reported engaging in moderate or vigorous physical activities less than three days a week. Consumption of junk foods was highly frequent among the students, with 61% reporting consumption of oil-fried snacks three or more days a week and 53.5% consuming sugary snacks three or more days a week. Fruit and vegetable consumption was low. Acanthosis nigricans (neck) was found in 26% of the students. Nearly 33% of the students had recreational screen time greater than three hours per day. **Conclusion:** The study results show that a major proportion of middle-late adolescents have behavioural, and physiological risk factors for NCDs, warranting strong preventive measures to be adopted at school level itself. Strategies aimed at awareness generation, increasing availability of and accessibility to healthy food and physical activity habits, as well as regular anthropometric and blood pressure screenings with follow up provisions in the schools need to be implemented.

Key Words: Adolescents, Diet, Physical Activity, Tobacco, Stress, Hypertension, Obesity

Introduction:

The rising burden of non-communicable diseases (NCDs) and associated health and socio-economic consequences present an overwhelming challenge and risk to health systems and economies worldwide, especially in low-middle income countries like India. In order to equip the health system to be able to address the increasing levels of NCDs, strategies for preventive measures aiming at early intervention points in the disease pathogenesis need to be explored and implemented. Studies have shown that this process starts from childhood itself and is influenced to a large extent by unhealthy lifestyle practices (1,2). The modifiable risk factors for the majority of the NCDs like unhealthy diet, physical inactivity, alcohol and tobacco abuse have been on the rise among the various sections of the population, leading to physiological risks like overweight and obesity, elevated blood pressure, dyslipidemia etc. resulting in full-fledged NCDs even among youth (3-7). Unhealthy lifestyles need to be intervened at early in life before they turn into life-long habits. It is in this background that, NCD prevention strategies in children and adolescents gain importance. The lifestyle and habits of persons are greatly influenced by social, economic, and cultural factors, which often vary between different age groups, genders, geographical locations, socio-economic strata, popular culture etc. It is important to understand these variances in order to create and implement effective behavioural change communication strategies for prevention of diseases like NCDs. However, comprehensive NCD risk factor studies among middle-late adolescent population in India, who are about to enter adulthood have been rare. Therefore, we aimed to assess the Non-Communicable Disease risk factors among the adolescents in the present study.

Materials and Methods

This was a cross-sectional study, conducted in 15 selected Government/Government-aided Higher Secondary Schools in Thiruvananthapuram district in Kerala. For the study, 1852 class eleven students were recruited through a multi-stage cluster sampling. Five schools each were selected from the three educational sub-districts in Thiruvananthapuram district, and students belonging to the randomly selected divisions among the Higher Secondary study streams in the selected schools were included in the study. The required minimum sample size was 1692, calculated using an expected prevalence of 7.98% of hypertension with 95 percent confidence interval which was obtained from a school-based study conducted in Thiruvananthapuram district, Kerala, with a precision of 2% and design effect of two, and a non-response rate of 20% (8). All children who were present on the date of assessment, in the selected divisions, and whose parents gave consent to the participation were included in the study after obtaining the assent of each student. Students who had learning and intellectual disabilities were excluded.

The study assessed the behavioural, psychosocial as well as physiological risk factors for NCDs among the students, which included the food habits, physical activity levels, screen use, substance abuse, and perceived stress levels of the students, along with anthropometric measurement to record Body Mass Index (BMI), Blood Pressure (BP) examination, and neck examination for Acanthosis nigricans.

Study Tools

The socio-demographic details, dietary habits, physical activity profile, substance abuse profile, and perceived stress levels of the students were assessed using a structured, pre-validated questionnaire in the local language. Anthropometric measurements and Blood Pressure readings were also taken, by trained medical professional. Weight in Kilograms (Kgs) corrected to the nearest 0.01 Kg, and height in centimetres were recorded using a digital weighing scale, and a portable stadiometer respectively, which were calibrated for use. BP was measured after the child rests for at least 5 minutes in a sitting position, using standardized, calibrated mercury sphygmomanometers, using auscultatory method in the right arm, using an appropriately sized cuff selected based on expert recommendations. Two separate readings were taken for each student at a ten-minute interval. BP classifications were made based on the latest American Academy of Pediatrics (AAP) guidelines. The average of two readings were taken as the final reading. Weight and height were converted to metric measurements in order to determine the Body Mass Index, represented as weight (kg) divided by the square of height (m^2) and classified based on the Indian Academy of Pediatrics' (IAP) Standardized BMI chart for Indian children, 'Extended International Obesity Task Force (IOTF)' measurement(9). A ten item Perceived Stress Scale, developed by Cohen et al, was used to measure the stress levels(10). A neck-grading of Acanthosis nigricans was also done for each student, based on the Burke et al grading.

Statistical Analysis

All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS, IBM, Chicago, IL, USA software 26.0) including percentages, frequency analysis, chi-square tests, and regression analysis. A statistical significance level was established at ($p < 0.05$).

Ethical Considerations

The study was carried out with the approval of the Institutional ethics committee. Participants were recruited only after obtaining informed consent from the guardian, as well as assent of the participants. Confidentiality and privacy of participants were maintained.

Results

A total of 1852 students were selected from the 15 schools. Girls constituted the majority of the participants (65.8%), and 76.1% were from rural backgrounds. The median age of the participants was 16 years. [Table 1]

Table 1: Socio-demographic Profile of the Study Participants		
Characteristic	Categories	N (%)
Gender	Male	632(34.2%)
	Female	1218(65.8%)
Academic Stream	Science	981(53%)
	Humanities	471(25.4%)
	Commerce	400(21.6%)
Socio-economic Background	Below Poverty Line	869(47.1%)
	Above Poverty Line	975(52.9%)
Place of Residence	Rural	1407 (76.1%)
	Urban	442 (23.9%)

Undesirable Food habits

Consumption of junk foods was highly frequent among the students, with 61% reporting consumption of oil-fried snacks on three or more days a week, and 53.5% consuming sugary snacks on three or more days a week. Around 12% of the students reported consuming Sugar Sweetened Beverages (SSBs) or Carbonated drinks on three days a week or more frequently. Consumption of sugary snacks was significantly higher in students belonging to rural backgrounds. Boys showed significantly more frequent consumption of SSBs and carbonated drinks than girls ($p < .001$). [Table 4] Fruit and vegetable consumption was low. Among the students, 54.4% reported fruit consumption on two days a week or less frequently, while the daily self-reported consumption was less than a handful in 72%. Fruit consumption was significantly less frequent among girl students from rural backgrounds as well as those belonging to lower socioeconomic status. Consumption of green leafy vegetables was very low- less than once a week in 31.8% students and was significantly low among girls ($p < .001$). Self-reported daily consumption of vegetables was less than a handful in 56.6% students, which was significantly low among students from economically backward families [Tables 2, 4]

Consumption of more than 6 teaspoons of added sugar per glass of daily beverage like milk, coffee, or tea was reported by 7.6% of the students, while 2.6% reported frequently adding salt to their food before eating. Added sugar consumption was higher among students from higher economic backgrounds while salt consumption was higher among boys and economically backward students. [Tables 2, 4]

Physical Inactivity

Around 62% of the participants reported engaging in moderate or vigorous physical activities less than three days a week. Physical activity levels of girls were significantly low ($p < .001$). [Tables 2,4] Nearly 33% of the students had a recreational screen time of more than three hours a day. This was significantly higher among boys ($p < .001$), with more than 50% reporting high recreational screen use.

Tobacco abuse

Current habit of smoking was reported by 1.3% of the students, while current use of smokeless tobacco products was reported by 0.7%. This was significantly higher among boys and those from rural backgrounds.

Perceived Stress

High level of Perceived Stress was reported by 6.4% of students. Stress was found to be higher in girls.

Table 2: Behavioural Risk factors						
Characteristic	Male	Female	BPL	APL	Rural	Urban
Sugary snacks on ≥ 3 days/ week	393 (62.58%)	726 (60.25%)	522 (60.70%)	595 (61.59%)	875 (62.81%)	244 (55.58%)
Fried snacks on ≥ 3 days/ week	341 (54.13%)	639 (53.12%)	441 (51.34%)	534 (55.22%)	734 (52.65%)	246 (56.16%)
Aerated drinks & Sugar Sweetened Beverages on ≥ 3 days/ week	140 (22.12%)	82 (6.80%)	106 (12.28%)	115 (11.87%)	174 (12.44%)	48 (10.93%)
Fruit consumption less than thrice a week	334 (53%)	666 (55.1%)	495 (57.6%)	499 (51.3%)	774 (55.4%)	225 (51.1%)
Green leafy vegetables - less than once a week	161 (25.6%)	421 (35.1%)	270 (31.4%)	310 (32.2%)	430 (35.9%)	151 (34.4%)
Fruit consumption less than a handful a day	436 (68.77%)	895 (73.48%)	653 (75.14%)	672 (68.92%)	1029 (73.13%)	300 (67.87%)
Vegetable consumption less than a handful a day	369 (58.20%)	679 (55.75%)	524 (60.30%)	520 (53.33%)	801 (56.93%)	245 (55.43%)
Habit of consuming salty foods	197 (31.07%)	419 (34.40%)	296 (34.06%)	316 (32.41%)	467 (33.19%)	148 (33.48%)
Uses ≥ 6 teaspoon sugar per glass of daily beverage	54 (8.52%)	87 (7.14%)	55 (6.33%)	86 (8.82%)	110 (7.82%)	31 (7.01%)
Moderate-Vigorous Physical Activity on < 3 days a week	305 (48.26%)	845 (69.83%)	527 (61.00%)	618 (63.65%)	875 (62.37%)	275 (62.79%)
Recreational Screen use ≥ 3 hours/day	309 (50.16%)	288 (24.04%)	279 (32.90%)	316 (32.92%)	468 (33.86%)	129 (29.86%)
Current smoking	21 (3.35%)	2 (0.17%)	9 (1.05%)	14 (1.45%)	23 (1.65%)	0 (0.00%)
Current abuse of smokeless tobacco	13 (2.06%)	0 (0.00%)	6 (0.7%)	7 (0.72%)	13 (0.93%)	0 (0.00%)

Table 3: Psychosocial and Physiological Risk Factors						
Characteristic	Male	Female	BPL	APL	Rural	Urban
High level of Perceived Stress	30 (4.73%)	88 (7.22%)	61 (7.02%)	57 (5.85%)	89 (6.33%)	29 (6.56%)
Overweight	71 (11.27%)	191 (15.17%)	108 (12.5%)	154 (15.79%)	194 (13.83%)	68 (15.41%)
Obese	35 (5.56%)	84 (6.91%)	45 (5.21%)	74 (7.59%)	79 (5.63%)	40 (9.07%)
Grade 1 Hypertension	174 (27.44%)	266 (21.84%)	182 (20.94%)	258 (26.46%)	342 (24.31%)	98 (22.17%)
Grade 2 Hypertension	57 (8.99%)	96 (7.88%)	58 (6.67%)	95 (9.74%)	120 (8.53%)	33 (7.47%)
Hypertensive or Overweight	218 (34.60%)	352 (29.00%)	258 (29.90%)	312 (32.03%)	449 (32.05%)	121 (27.44%)
Hypertensive and Overweight	64 (10.16%)	146 (12.03%)	80 (9.27%)	130 (13.35%)	143 (10.21%)	67 (15.19%)
Acanthosis nigricans	113 (18.14%)	366 (30.27%)	212 (24.77%)	266 (27.45%)	350 (25.13%)	129 (29.52%)
Acanthosis grade 3 and above	16 (2.57%)	97 (8.02%)	47 (5.49%)	66 (6.81%)	81 (5.81%)	32 (7.32%)

Table 4: Gender differences of Non-Communicable disease risk factors				
Characteristic	Category	Male	Female	Significance
		n (%)	n (%)	
Aerated drinks and Sugar Sweetened Beverages	0-2 days a week	493 (77.88%)	1124 (93.20%)	< 0.001
	Three or more days a week	140 (22.12%)	82 (6.80%)	
Fruit consumption on a typical day	Less than a handful a day	436 (68.77%)	895 (73.48%)	< 0.05
	One or more handful a day	198 (31.23%)	323 (26.52%)	
Green leafy vegetables	0-2 days a week	161 (25.60%)	421 (35.05%)	< 0.001
	Three or more days a week	468 (74.40%)	780 (64.95%)	
	Often/Always	24 (3.79%)	24 (1.97%)	
Vigorous or moderate intensity physical activity	0-2 days a week	305 (48.26%)	845 (69.83%)	< 0.001
	Three or more days a week	327 (51.74%)	365 (30.17%)	
Recreational Screen use	0-3 hours a day	307 (49.84%)	910 (75.96%)	< 0.001
	More than 3 hours a day	309 (50.16%)	288 (24.04%)	
Current habit of smoking	No	606 (96.65%)	1202 (99.83%)	< 0.001
	Yes	21 (3.35%)	2 (0.17%)	
Current use of smokeless tobacco	No	617 (97.94%)	1210 (100.00%)	< 0.001
	Yes	13 (2.06%)	0 (0.00%)	
Perceived Stress	Low-moderate	604 (95.27%)	1130 (92.78%)	< 0.05
	High	30 (4.73%)	88 (7.22%)	
Body Mass Index	Not overweight	524 (83.17%)	941 (77.38%)	< 0.05
	overweight	106 (16.83%)	275 (22.62%)	
Blood Pressure	Normal	460 (72.56%)	952 (78.16%)	< 0.05
	Hypertension	174 (27.44%)	266 (21.84%)	
Acanthosis nigricans (neck)	Absent	510 (81.86%)	843 (69.73%)	< 0.001
	Present	113 (18.14%)	366 (30.27%)	

Body Mass Index

Anthropometric measurements of only 1846 students could be taken due to locomotor disabilities in six of the students. Around 19% of the students were overweight, while 6.4% were obese. Girls, economically forward students and urban residents had significantly higher levels of overweight than their respective counterparts. Obesity was higher among economically forward and urban students.

Blood Pressure

Around 24.7% of the students had Grade I Hypertension, and 8.3% had Grade II Hypertension as per the latest AHA guidelines. Boys and economically forward students had significantly higher levels of Grade I Hypertension. Grade II Hypertension was significantly higher among economically forward students. Nearly 31% of the students were either overweight or hypertensive. About 11.4% were both overweight and hypertensive.

Acanthosis nigricans

Acanthosis nigricans (neck) was found in 26% of the students. Around 6% students had acanthosis neck severity Grade 3 and above. This was significantly higher among girls ($p < .001$).

Discussion

The study explored the behavioral, psychosocial, and physiological risk factors for NCDs among mid-late adolescents. Consumption of calorie-dense snacks was highly prevalent among the students. More than 53% of the adolescents reported consuming fried foods three or more days a week, similar to a 2016 Centre for Science and Environmental studies (CSE) survey among children aged 9-17 years from 300 schools across the country (11). Frequent consumption (greater than two times a week) of fast foods and junk foods have been found to be associated with higher BMIs in children (12,13). Sugar sweetened beverages increase the daily sugar intake, and their frequent consumption has been found to be associated with obesity, and dental caries in children (12). Also, added sugar in daily beverages was found to be six teaspoons or more in 7.6% of the students, while this was three teaspoons or more in 67% of them. While this seems moderate level of consumption while taken individually, the complete picture is alarming, with more than 65% of students who took three or more teaspoons of added sugar in their daily beverages also consumed sweet snacks three or more days a week, raising concern on the daily added sugar intake by the adolescents, which can easily exceed the advisable six-teaspoon limit. (14). Similar was the case with adding salt to food at the table, with those who add salt to food at the table occasionally or more frequently having higher consumption of salty foods like pickles, pappad etc. along with very low consumption of vegetables. The IAP has recommended limiting the consumption of junk foods, ultra-processed foods, nutritionally inappropriate foods, carbonated/ caffeinated/ coloured beverages, and sugar sweetened beverages (JUNCS) by children and adolescents to not more than one serving per week (12). The availability of such food items needs to be restricted and healthier, locally made alternative snacks need to be made available in and around school campuses. Also, community level awareness generation, especially of parents is very essential to limit such unhealthy food habits.

Fruit and vegetable consumption was inadequate in terms of frequency and quantity. The recommended daily intake of fruits and vegetables is 350-400 grams a day (15). Inadequate consumption of fruits and vegetables have been linked to various health problems like NCDs, including cancers of the gastro-intestinal tract, and consumption of two or more servings of vegetables, and fruits have been shown to reduce NCD risk including improvement in blood parameters like cholesterol levels (15-18). In the present study, fruit consumption was less but vegetable consumption was higher among rural residents compared to their urban counterparts. Similar results have been shown in household surveys in

India (19). Economically forward students had significantly higher fruit and vegetable consumption than their counterparts, pointing towards the economic accessibility factor. The results show that measures to promote fruit and vegetable consumption among adolescents need to be implemented, with emphasis on awareness generation, and strategies to improve availability of such healthy foods instead of undesirable food choices in schools.

Physical inactivity was significantly higher in girls. Boys reported significantly higher amounts of moderate and vigorous physical activities, whereas significantly more girls engaged in household chores involving low-moderate physical exertion. Students from BPL families reported better engagement in vigorous physical activity, and household physical activity than their APL counterparts. This was also reflected in their BMIs, as girls and APL students had significantly higher levels of overweight and obesity than their respective counterparts. This resonates with several other studies conducted in children and adults in the country. (20-22). In the present study, screen use was higher than that of younger school-going adolescents in the state, (23) while it was lower than that in urban settlements in metro cities of India (24).

Stress levels were moderate to high in more than three-quarters of the study group. Comparable levels of stress have been reported in studies among adolescents in Kerala and other parts of India (25-27). Female students were found to be highly stressed which was comparable to previous studies (26). Unlike other studies, socioeconomic status was not associated with higher stress levels in the present study (25). Prevalence of smoking and smokeless tobacco use was comparable to studies in younger adolescents, while lower than that of youth (28,29).

The prevalence of hypertension and overweight conditions was comparable to that of the levels in young adult and older population from the National Family Health Survey-5, with nearly a third of the adolescents, and a fourth of them having high blood pressure and BMI (30). Girls, students belonging to higher socio-economic classes tended to have higher levels of obesity and lower levels of physical activity. Other studies have also reported higher prevalence of obesity in girls, those with low physical activity, and higher income families (31-33). The Acanthosis levels in the present study was higher when compared to the 16% prevalence in a recent South Indian study (34). Acanthosis Grade 3 and above was found in more than 6% of the students, and these children have a high risk for non-communicable diseases like Diabetes, and fatal Cardiovascular complications, unless appropriate preventive measures are taken.

The present study used self-reported diet, physical activity, screen and substance abuse habits among the students to assess behavioural risk factors, but each question was read out with uniform explanations for limiting bias. Food consumption in the previous normal week from the day of data collection was advised for consideration on reporting the frequency of intake of different food groups to limit recall bias. The study did not include biochemical parameters to ascertain the NCD risk in students, but the high levels of hypertension, overweight and Acanthosis nigricans indicate a need for such parameters in future research.

The higher levels of physiological risk factors indicate that a significantly large number of non-communicable diseases will contribute to the NCD burden in the state in the near future, unless appropriate interventions are taken. NCD preventive measures, including active screening of adolescents need to be implemented at the school levels for timely identification and intervention to prevent and limit the morbidity, premature mortality and socioeconomic consequences of NCD's.

Conclusion

The study results show that a major proportion of middle-late adolescents have behavioural, and physiological risk factors for NCD's, warranting strong preventive measures to be adopted at school level itself. Strategies aimed at awareness generation, increasing availability of and accessibility to healthy food and physical activity habits, as well as regular anthropometric and blood pressure screenings with follow up provisions in the schools need to be implemented.

Conflicting Interests:

The authors declare no potential conflicts of interest.

Funding sources:

This research did not receive any funds from funding agencies in the public or commercial sectors.

Acknowledgements:

The researchers acknowledge the Directorate of Higher Secondary Education, Kerala for the support provided in conducting and coordinating the study.

References

1. Tuzcu EM, Kapadia SR, Tutar E, et al. High Prevalence of Coronary Atherosclerosis in Asymptomatic Teenagers and Young Adults. *Circulation*. 2001;103:2705–2710.
2. Strong JP, Malcom GT, McMahan CA, et al. Prevalence and Extent of Atherosclerosis in Adolescents and Young Adults Implications for Prevention From the Pathobiological Determinants of Atherosclerosis in Youth Study. *JAMA* 1999;281:727–735.
3. Guthold R, Stevens GA, Riley LM, et al. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1-6 million participants. *Lancet Child Adolesc Health*. 2020;4:23–35.
4. Haokip N, Sharma S. Trends in fast food consumption among adolescents in Ludhiana (Punjab). *FOOD Sci Res J*. 2016;7:276–280.
5. Latimer W, Zur J. Epidemiologic Trends of Adolescent Use of Alcohol, Tobacco, and Other Drugs. *Child Adolesc Psychiatr Clin N Am* 2010;19:451–464.
6. Cosma A, Stevens G, Martin G, et al. Cross-National Time Trends in Adolescent Mental Well-Being From 2002 to 2018 and the Explanatory Role of Schoolwork Pressure. *J Adolesc Health*. 2020;66:S50–S58.
7. Biswas T, Townsend N, Huda MM, et al. Prevalence of multiple non-communicable diseases risk factors among adolescents in 140 countries: A population-based study. *EClinical Medicine*. 2022;52:101591.
8. George B, Scarai ML, Ahamed ZM et al. Hypertension Among Adolescent School Children Aged 15–18 Years In An Urban Government School, Kerala. *Indian Journal of Applied Research*. 2018;8(5)
9. Vaman K, Sangeeta Y, Aggrawal K, et al. Revised IAP Growth Charts for Height, Weight and Body Mass Index for 5- to 18-year-old Indian Children. *Indian Pediatr*. 2015;52:47–55.
10. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983;24:385–396.
11. Bhushan C, Taneja S KA. Burden of Packaged Food on Schoolchildren: Based on the CSE survey 'Know Your Diet' 2017. Available at: https://cdn.cseindia.org/attachments/0.37055100_1520598445_burden-packaged-food-school-children.pdf. Accessed May 29 2024
12. Gupta P, Shah D, Kumar P, et al. Indian Academy of Pediatrics Guidelines on the Fast and Junk Foods, Sugar Sweetened Beverages, Fruit Juices, and Energy Drinks. *Indian Pediatr* 2019;56:849–863.
13. Khan MI, K L, Patil R, et al. A Study Of The Risk Factors And The Prevalence Of Hypertension In The Adolescent School Boys Of Ahmedabad City. *J Clin Diagn Res Ser Online*. 2010;4:3348–3354.
14. Vos MB, Kaar JL, Welsh JA, et al. Added Sugars and Cardiovascular Disease Risk in Children: A Scientific Statement From the American Heart Association. *Circulation*. 2017;135:e1017–e1034.
15. WHO. Increasing fruit and vegetable consumption to reduce the risk of noncommunicable diseases. e-Library of Evidence for Nutrition Actions (eLENA). E-Libr. Evid. Nutr. Actions ELENA. 2023. Available at: <https://www.who.int/tools/elena/interventions/fruit-vegetables-neds>. Accessed May 30 2024
16. Miller V, Mente A, Dehghan M, et al. Fruit, vegetable, and legume intake, and cardiovascular disease and deaths in 18 countries (PURE): a prospective cohort study. *The Lancet*. 2017;390:2037–2049.
17. Aune D, Giovannucci E, Boffetta P, et al. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality-a systematic review and dose-response meta-analysis of prospective studies. *Int J Epidemiol* 2017;46:1029–1056.
18. Yuan C, Lee H-J, Shin HJ, et al. Fruit and vegetable consumption and hypertriglyceridemia: Korean National Health and Nutrition Examination Surveys (KNHANES) 2007–2009. *Eur J Clin Nutr*. 2015;69:1193–1199.
19. National Sample Survey Office. Household Consumer Expenditure, NSS 68th Round Sch1.0 Type 1: July 2011–June 2012. Available at <http://www.icssrdataservice.in/datarepository/index.php/catalog/91>. Accessed June 10 2024
20. Anjana RM, Pradeepa R, Das AK, et al. Physical activity and inactivity patterns in India - results from the ICMR-INDIAB study (Phase-1) [ICMR-INDIAB-5]. *Int J Behav Nutr Phys Act* 2014;11:26.
21. John M, Naha NK, Cherian VJ. Physical activity, sedentary behaviours and eating habits among school children in Kerala. *Pediatr Rev Int J Pediatr Res*. 2016;3(3).
22. Balan S. A study on the eating habits of adolescents in Thiruvananthapuram City, Kerala. *Int J Home Sci*. 2016;2:287–290.
23. Ramya KR. Screen Time Behaviours among School going Adolescents Residing in a Selected District, Kerala. *International Journal of Pediatric Nursing*. 2018;4(2)
24. Dubey M, Nongkynrih B, Gupta SK, et al. Screen-based media use and screen time assessment among adolescents residing in an Urban Resettlement Colony in New Delhi, India. *J Fam Med Prim Care* 2018;7:1236–1242.
25. Rentala S, Nayak RB, Patil SD, et al. Academic stress among Indian adolescent girls. *J Educ Health Promot*. 2019;8:158.
26. Bhaskar K, Watode, Kishore J, et al. Prevalence of Stress among School Adolescents in Delhi. *Indian J Youth Adolesc Health*. 2015;2:4–9.
27. Ragesh G, Sabitha C, Anithakumari A, Hamza A. Perceived Stress and Coping among Rural Adolescent Girls in India. *Int J Indian Psychol* 2015;2:170–173.
28. Grover S, Anand T, Kishore J, et al. Tobacco use among the youth in India: Evidence from Global Adult Tobacco Survey-2 (2016–2017). *Tob Use Insights*. 2020;13:1179173X2092739.
29. Jaisoorya TS, Beena K V, Beena M, et al. Prevalence & correlates of tobacco use among adolescents in Kerala, India. *Indian J Med Res* 2016;144:704–711.
30. People's Archive of Rural India. National Family Health Survey (NFHS-5) 2019-21: Kerala. Available at: <https://ruralindiaonline.org/bn/library/resource/national-family-health-survey-nfhs-5-2019-21-kerala/>. Accessed June 10 2024
31. Cherian AT, Cherian SS, Subbiah S. Prevalence of Obesity and Overweight in Urban School Children in Kerala, India. *Indian Pediatr* 2020;49:475–477.
32. Jacob JK, Jacob SK, George SB. Prevalence of Overweight and Obesity in Adolescent Children: A Cross Sectional Study. *Int J Sci Stud* 2016;4(6):50-54.
33. Prasad R, Bazroy J, Singh Z. Prevalence of overweight and obesity among adolescent students in Pondicherry, South India. *Int J Nutr Pharmacol Neurol Dis*. 2016;6:72–75.
34. Menon VU, Kumar KV, Gilchrist A, et al. Acanthosis Nigricans and insulin levels in a south Indian population-(ADEPS paper 2). *Obes Res Clin Pract*. 2008;2(1):I-II.