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# Cardio Metabolic Risk Factors among Adolescents in Rural Kerala, India

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***Abstract:***
*Cardio metabolic risk factors are a common adjunct of overweight and obesity. Present study was aimed at assessing the prevalence of cardio metabolic risk factors using anthropometric parameters among adolescents from selected rural communities in Kerala and to find the relationship between various risk factors and association with demographic variables. A sample of 455 adolescents was selected by multistage random sampling from 9 rural schools in two selected districts of central Kerala. Height, weight, waist, hip circumferences, and blood pressure were obtained using validated, reliable instruments. Demographic data was obtained using a questionnaire. Ethical clearance from IRB, administrative permission from authorities and assent from subjects were taken prior to data collection. Collected data was analyzed using SPSS vs. 18 in accordance with the objectives listed.*
*Risk factors were prevalent among rural adolescents in central Kerala;34.1% of the female subjects were overweight by their WHR values; 7.6% having visceral obesity by WC and WHtR values. Among the males, besides pre hypertension andhypertension, general obesity (2.1%), and visceral obesity(4.1%) were seen. Weight was a highly significant risk indicator; and the single most predictive ofsystolic and diastolic blood pressure. More females were found to be at risk categories (34.1% with WHR > 0.81; 7.6% with WC >81cm; and 7.6% with WHtR >0.51). Religion showed significant association with BMI ($p<0.05$), gender with WHR ($p<0.001$) and fathers' occupation with BMI and WHtR ($p=0.005$). The study ascertains the family, particularly the paternal role is pivotal in reducing cardio metabolic risk by altering the lifestyle of adolescents in rural Kerala.*

***Keywords:*** *Adolescents, cardio metabolic risk, anthropometric parameters*

## 1. Introduction

Cardio – metabolic fitness is an indicator of good health in adolescents. Recent reviews indicate a decline in cardiac and metabolic fitness, mostly attributed to overweight and obesity. Increasing prevalence of obesity across all age groups has become a global public health issue of concern.

## 2. Background

According to CDC reports, past 30 years has witnessed more than double the increase of obesity in children and more than four times the number in adolescents. Between 1980 and 2012, obesity among adolescents aged 12 to 19 years increased from 5% to 21%. Cardio metabolic risk factors are a byproduct of obesity epidemic.

The risk factors include resting heart rate, family history of heart disease, blood pressure readings, lipid levels, fasting blood glucose level and BMI. Healthy levels of lipids include Total cholesterol (LDL+HDL) below 200mg%, LDL at 100 mg% or below, HDL at 50mg% or above, and triglyceride below 150mg%. Normal fasting blood glucose level below 100mg% and a level above 100mg% and below 125mg% indicate pre diabetes while FBS above 125mg% indicate diabetes mellitus.

Normal Blood pressure is considered 110/70 mmHg, between 120/80 to 130/89 is considered pre hypertension and 140/90mmHg and above is termed hypertension. The ideal BMI value is 18.5 to 24.9, BMI of 25 to 29.9% is considered overweight and BMI of 30 is obesity. Waist to hip ratio (WHR) (normal: women $\leq 0.8$, men $\leq 0.9$) is considered as an atherogenic prognosticator (Noble, R E 2001).Waist Circumference (WC) and Weight to Height Ratio (WHtR) have been identified as a powerful tool superior to BMI for predicting cardio metabolic risk (Vadasseril TJ, 2015).In a meta-analysis of 24 cross sectional studies and ten prospective studies with 512,809 participants, WHtR was found to be superior to BMI in predicting DM, metabolic syndrome, cardio vascular disease and the associated mortality and early mortality particularly in Asian population (Savva SC, 2013)

Obesity in adolescents accompanies several co morbidities, to name a few; fatty liver disease, nonalcoholic steatohepatitis, breathing disorders, metabolic syndrome, insulin resistance, hypertension, hyperlipidemia, type 2 diabetes mellitus and orthopedic problems (Wess, 2004)[i] Reduced quality of life and premature death in early adulthood are complications of co morbidities. The contributory

factors to overweight and obesity in adolescents include inadequate physical activities, positive energy balance, food and consumption pattern, replacement of traditional diet with fast food, fried food, soft drinks, bakery items, along with lack of physical exercise, television viewing and motorized transportation.

A cross sectional study of 1000adolescents randomly selected from government, aided and unaided high schools of Ettumanoor, Kerala found prevalence of pre hypertension 30.5% in males and 24.5% in females. Hypertension was seen in 0.98% males and 0.34% females. Male gender, low socio economic status, overweight/ obese, low fruit consumption and soft drink consumption were found to be strong determinants (Madhavikutty AG, 2015).

A cross sectional study of 389 adolescents from urban and rural schools in Surat, Gujarat on prevalence of overweight and obesity reported high prevalence of obesity in urban (14.6%) than rural (12.8%), significantly among urban males. Meanwhile a reduction in underweight adolescents from 13.6% to 4.6% ($p<0.001$) was observed (Alok P, 2012)

A cross sectional study from Kerala among 518 adolescents selected by multistage random sampling from 9 urban schools identified 9.3% as overweight and 1.4% as obese based on their BMI values. Waist Circumference was above normal in 13.1% subjects; a gender wise analysis found more girls (50%) than boys (40.7%) affected with visceral adiposity against the recommended normal values; (WC: 90 cm for boys and 80 cm or less for girls). Presence of pre hypertension was observed; 3.47% having systolic BP 121 – 140 mmHg while 1.2% had hypertension (SBP 140-150mmHg).The corresponding diastolic BP was also found elevated; 2.1% had DBP in 86-90 range and one subject with DBP > 96mmHg. (Vadasseril TJ, 2015)Presence of cardio metabolic risk factors in early adolescence from urban area is a premonition of events in near future.

Globalization has transformed the rural life in to urban style in Kerala. NRIs employed across the globe from most of the families in Kerala had transformed traditional lifestyle of homemade foods and physical activity. Economic development and technological advancement has brought comfort zone in every home minimizing physical effort and causing energy conservation. As a result, overweight and obesity are developing from childhood onwards. A positive energy balance of 10% can lead to approximately a 13.5 kg increase in body weight within a year (Bray, 1987).

Present study was aimed at assessing the prevalence of cardio metabolic risk factors among adolescent populace hailing from rural areas of Ernakulam and Idukki districts of Kerala. Understanding the scenario will help to recognize the magnitude of problem and initiate effective steps at various levels to tackle the menace.

Statement of the problem: An exploratory study on cardio metabolic risk factors among adolescents from rural Kerala.

*Objectives*: 1. To assess the prevalence of cardio metabolic risk factors using anthropometric parameters among adolescents from selected rural communities in Kerala. 2. To find the relationship between various risk factors. 3. To find the association of anthropometric parameters with the demographic variables.

## 3. Methodology

A total of 455 adolescents in the age group of 13 to 16 years were selected by multistage random sampling from 9 high schools located in rural areas of two districts of Kerala. Using a quantitative approach and exploratory descriptive design, investigator developed validated and retested tool was administered to gather data on demographic profile and anthropometric parameters; height, weight, waist and hip circumferences, blood pressure and resting pulse rate. Ethical clearance and administrative approval were sought. Assent from subjects were obtained after explaining their role and assuring them of confidentiality. Height, weight and systolic and diastolic blood pressure were recorded using standard valid and reliable instruments. Weight was taken with standard uniform without shoes. Blood pressure was taken manually on right arm in sitting position using sphygmomanometer and stethoscope. Waist circumference was taken at the narrowest point below rib cage and above iliac crest; hip circumference at the level of greater trochanter using inch tape. Waist to hip circumference ratio was calculated as waist circumference / hip circumference (WHR) = (normal: women $\leq 0.8$, men $\leq 0.9$). BMI was calculated using the formula: weight (kg)/ [height (m)] $^2$, (Normal $\leq 25$). Waist to height ratio (WHtR) was calculated as waist circumference /Height (Normal WHtR = <0.5). The data was analyzed on SPSS vs.18 in accordance with the objectives.

## 4. Results

The data obtained from 455 adolescents studying in 9$^{th}$ standards of 9 rural schools, who met the inclusion criteria were organized, analyzed using descriptive and inferential statistics on SPSS vs.18 and interpreted in accordance with the stated objectives. The findings are presented in tables and graphs.

### *4.1. Section 1. Demographic Characteristics*

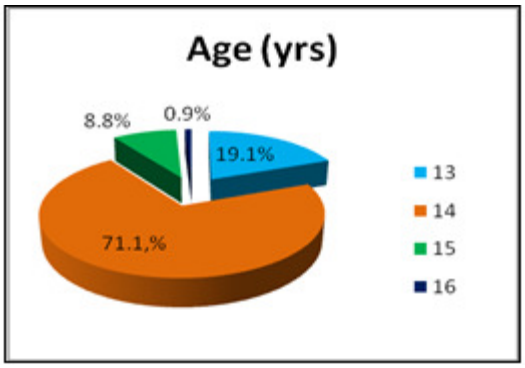


*Figure 1: Distribution of subjects by age*

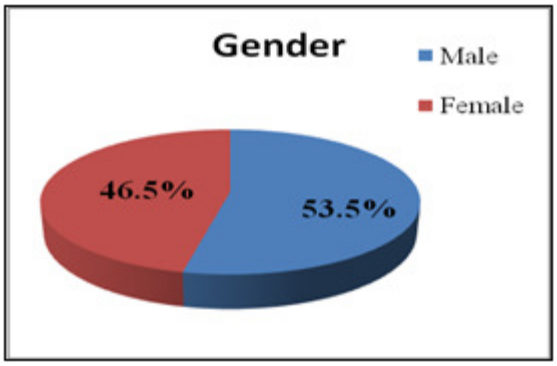


*Figure 2: Distribution of subjects by gender*

Majority (71.1%) subjects were 14 years old; male subjects (53.5%) exceeded the females.

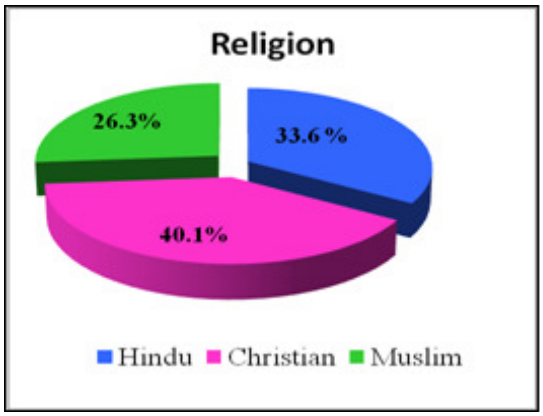


*Figure 3: Distribution of subjects by religion*

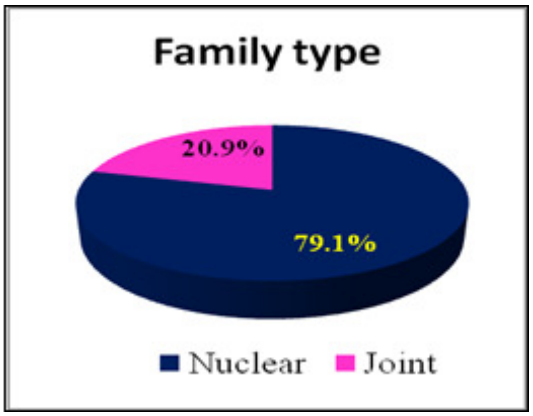


*Figure 4: Distribution of subjects by family type*

Majority (40.1%) was Christian; 79% subjects were hailing from nuclear families.

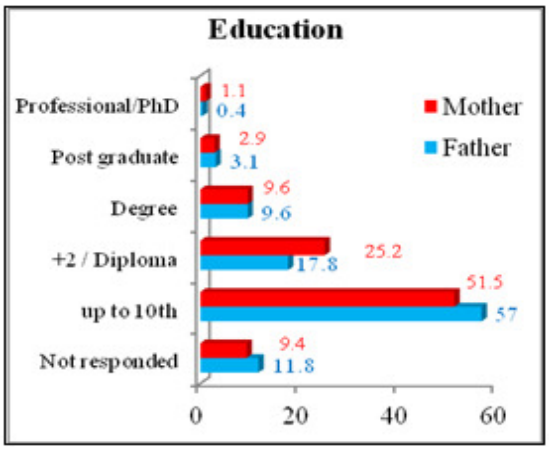


*Figure 5: Distribution (%) by education*

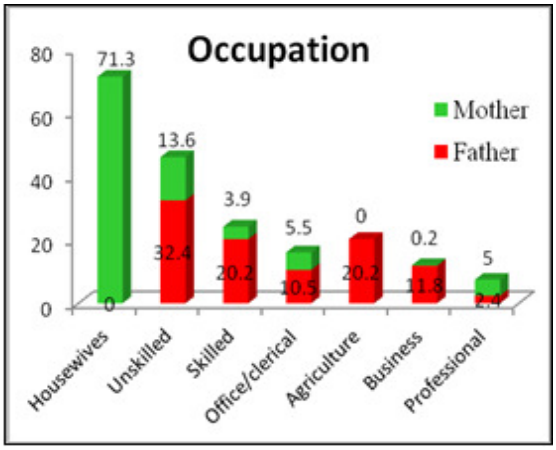


*Figure 6: Distribution (%) by occupation*

More than half of the subjects had their parents educated up to $10^{th}$ Std and 10% were graduates; no one illterate was reported. Motheres mostly(71.3%) were housewives; fathers unskilled (32.4%) and 5% mothers and 2.4% fathers were professionals.

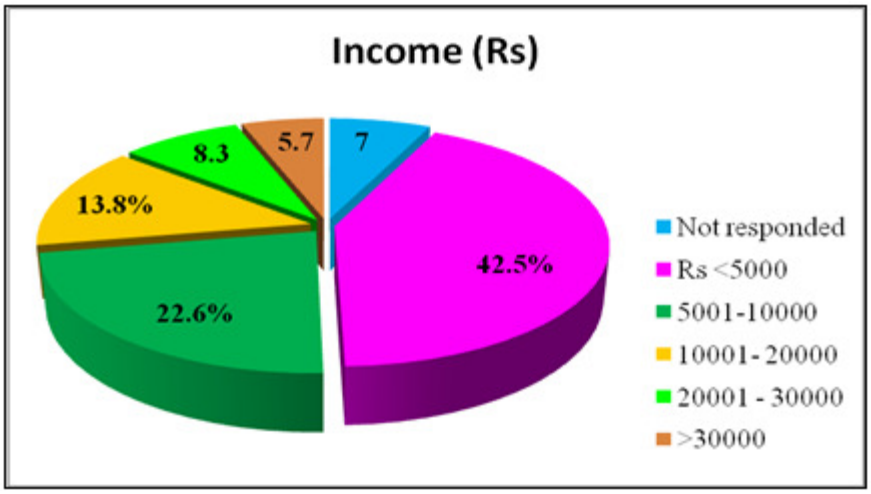


*Figure 7: Percentage distribution of subjects by monthly family income.*

Majority belongedlow income group(Rs<5000/month)while 5.7% had higher income.

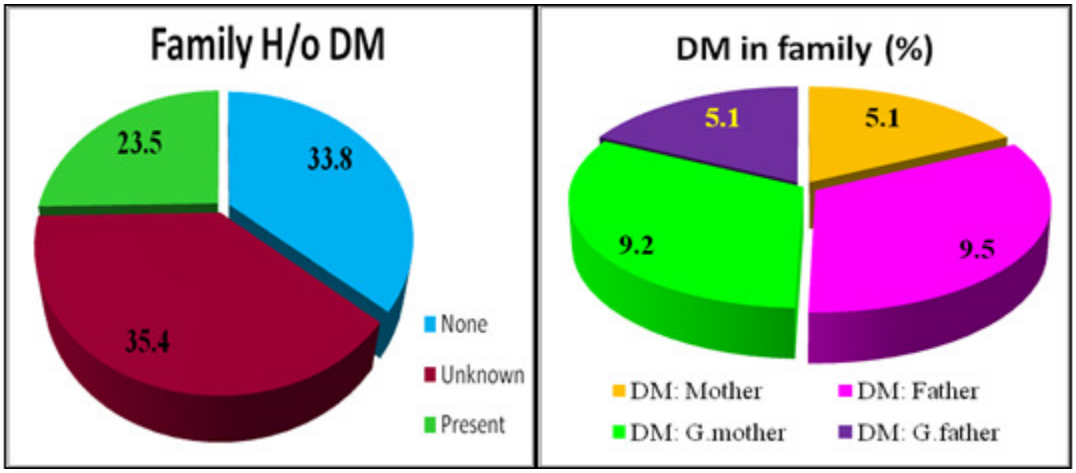


*Figure 8: Distribution of subjects showing family history of Diabetes Mellitus and realtionships*

Presence of diabetes mellitus in the family was prevalentamong 23.5% ;among those affected, grandmothers and fathers were more so than mothers and grandfathers (Fig- 7).

*4.2 . Section 2. Findings Related to Cardio Metabolic Risk Factors Based Onanthropometric Data.*

Cardio metabolic indicators such as BMI,WHR, WC and WHtR were calculated gender wise from anthropometric parameters are presented below in figures.

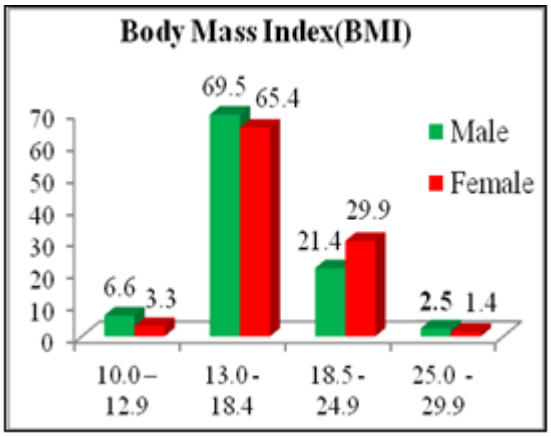


*Figure 9: Distribution (%) of subjects by BMI*

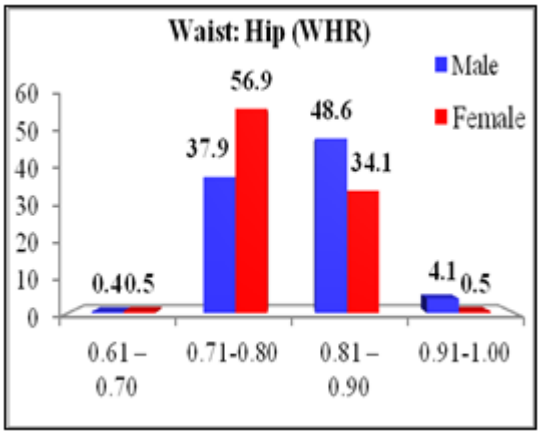


*Figure 10: Distribution (%) of subjects by WHR*

Overweight observed in 2.5% boys and 1.4% girls; BMI did not identify those with obesity.WHR indicated more overweight females (34.1%) while obesity was more in males(4.1%).

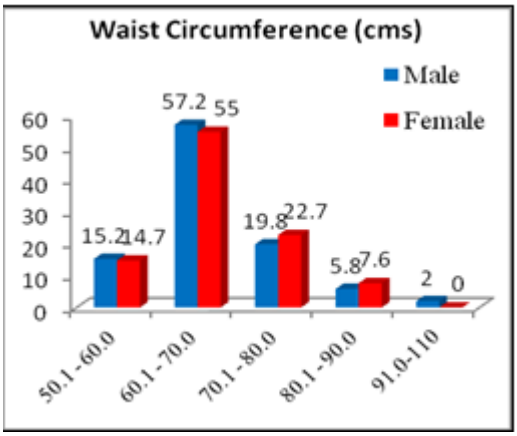


*Figure 11: Distribution (%) of subjects by WC.*

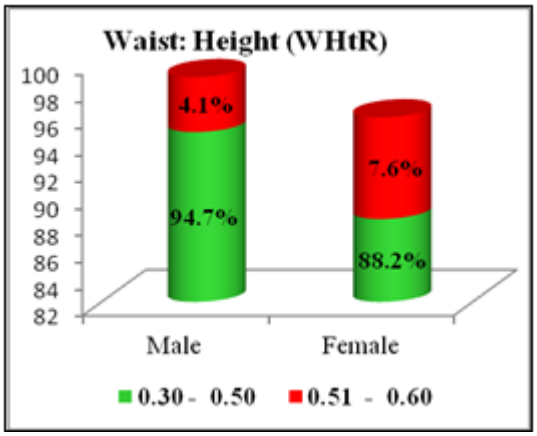


*Figure 12: Distribution (%) of subjects by WHtR*

WC showed overweight females (7.6%) exceeding males (5.8%); obesity (2%) seen in males only. Visceral obesity as seen by WHtR values was 7.6% in females; compared to 4.1% in males.

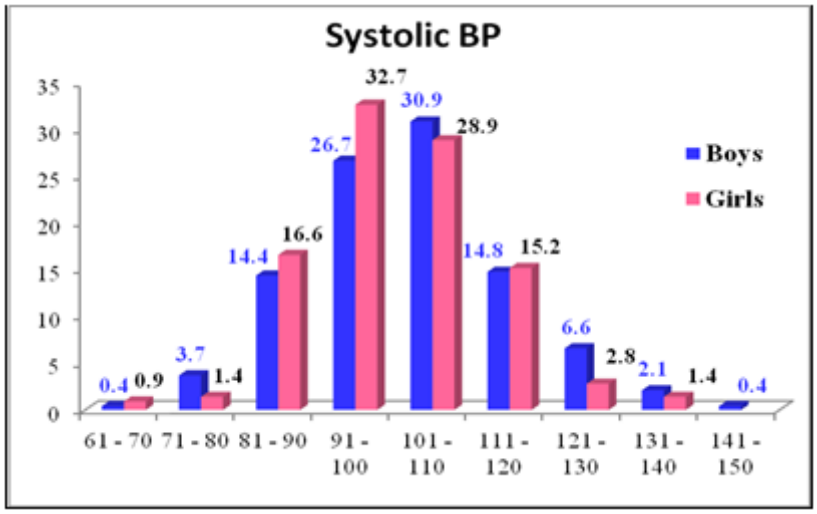


*Figure 13: Percentage dstribution of subjects showing systolic BP gender wise.*

Systolic pre hypertension was observed in 15.2% male and 14.8% female adolescents; while hypertension (2.5%) was more among male adolescents (Fig.13).

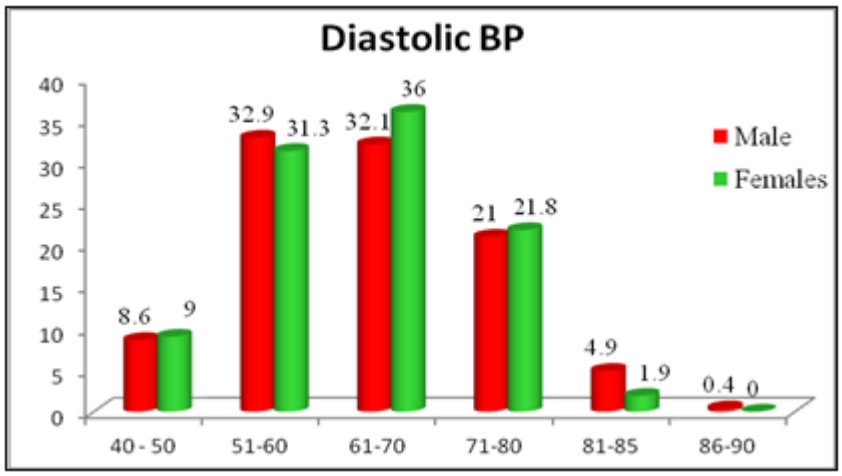


*Figure 14: Percentage distribution of subjects showing disatolic BP gender wise.*

Pre hypertension (4.9%) and hypertension(0.4%) was observed more in male adolescents.

*4.3 Section 3. Associationof Cardio Metabolic Risk Factors with Selected Demographic Variables among Adolescents in Rural Kerala.*

| **Variable characteristics** | **Male** | | **Female** | | **Total** | | **$\chi^2$ values df, p-values** |
|---|---|---|---|---|---|---|---|
| WHR | *F* | % | *f* | % | f | % | |
| 0.61 – 0.70 (*low*) | 1 | 0.4 | 1 | 0.5 | 2 | 0.5 | |
| 0.71 - 0.80 (*Normal*) | 92 | 37.9 | 120 | 56.9 | 212 | 50.96 | $\chi^2$=21.728[a] df = 6, p< 0.001*** |
| 0.81 – 0.90 (*Normal; male*) | 118 | 48.6 | 73 | 34.1 | 192 | 46.15 | |
| 0.91 - 1.00 (*overweight*) | 10 | 4.1 | 1 | 0.5 | 11 | 2.64 | |
| **Total** | 221 | 53.13 | 195 | 46.88 | 416 | 100 | |

*Table 1: Association of WHR with gender among adolescents in rural Kerala.*
**** Highly significant at p<0.001.*

The waist to hip ratio (WHR) showed highly significant association with gender (p<0.001). The normal WHR being <0.80 for females, 34% had WHR >0.81 showing overweight against 4.1% males (WHR >0.91) (Table 1).

| **Variable** | **Characteristic** | **RELIGION** | | | **Total f (%)** | **$\chi^2$ value, df, p-value** |
|---|---|---|---|---|---|---|
| | | Hindu f (%) | Christian f (%) | Muslimf (%) | | |
| BMI | 13.0 - 18.4 | 72 (15.82) | 76(16.70) | 47 (10.33) | 195(42.86) | $\chi^2$=10.634df=4 *p=0.031** |
| | 18.5 - 24.9 | 73 (16.04) | 96(21.09) | 56 (12.31) | 225(49.45) | |
| | 25.029.9 | 8 (1.76) | 10 (2.97) | 17 (37.36) | 35 (7.69) | |
| Total | | 153(33.63) | 182 (40) | 120(26.37) | 455(100) | |

*Table 2: Association of BMI with religion among adolescents in rural Kerala.*
**Significant at p<0.05.*

Body Mass Index (BMI) showed significant association (p<0.05) with religion; 37.36% Muslim subjects were found overweight against 2.97% Christian and 1.76% Hindu subjects (p<0.05) (Table 2).

| **Characteristics** | **Body Mass Index (BMI)** | | | **Total *f* (%)** | **$\chi^2$ values, df, p-values** |
|---|---|---|---|---|---|
| | Low *f (%)* | Normal *f (%)* | Overweight *f* (%) | | |
| Father's occupation | 13.0 -18.4 | 18.5 -24.9 | 25.0 - 29.9 | | |
| No response | 9(1.9) | 5(1.1) | 0 (0) | 14 (3.08) | **$\chi^2$=37.064** df =18 *p= **0.005**** |
| Unskilled | 73 (16.8) | 61 (13.44) | 4 (0.88) | 138(30.39) | |
| Skilled | 40 (8.81%) | 41 (9.03) | 10 (2.20) | 91(20.04) | |
| Office/clerical | 15 (3.30) | 30 (6.6) | 3 (0.66) | 48(10.58) | |
| Professional | 4(0.88) | 7 (1.54) | 0 (0) | 11(2.42) | |
| Business | 11 (2.42) | 33 (7.27) | 10 (2.20) | 54(11.89) | |
| Agriculture | 39 (8.6) | 45 (9.91) | 7 (1.54) | 91(20.04) | |
| Other | 4(0.88) | 2(0.44) | 1 (0.02) | 7(1.54) | |
| Total | 195(42.95) | 224 (49.34) | 35(7.7) | 454 (100) | |

*Table 3: Association of BMI and father's occupation among adolescents in rural Kerala.*
****Significant at p<0.01***

Parental occupation particularly occupation of the father showed significant association with regard to the BMI of their adolescent children. While 16.8% subjects whose father did unskilled jobs, the BMI was less than 18.0 showing under nutrition; whereas overweight was seen mostly among parents who did business or skilled jobs (2.20%)(Table -3).

| **Occupation: Father** | **WHtR values** | | **Total** | **$\chi^2$ values,df, p-values** |
|---|---|---|---|---|
| Characteristics | 0.30 -0.50 (Normal) | 0.51- 0.60 (Elevated) | | |
| No response | 13 | 0 | 13 | $\chi^2$=37.064[a] df =18 *p=0.005*** |
| Unskilled | 134 | 3 | 137 | |
| Skilled | 88 | 2 | 90 | |
| Office/clerical | 39 | 5 | 44 | |
| Professional | 11 | 0 | 11 | |
| Business | 44 | 8 | 52 | |
| Agriculture | 82 | 7 | 89 | |
| Other | 6 | 1 | 7 | |
| Total | 416 | 26 | 443 | |

*Table 4: Association of WHtR with father's occupation among adolescents in rural Kerala*
***Significant at p<0.01*

Father's occupation had shown significant association (p<0.01) with the weight to height ratio (WHtR) of their adolescent children. Except professionals, all other groups; business followed by agricultural, clerical, unskilled and skilled job holders' group displayed visceral obesity (WHtR>0.51) (Table 4).

| Correlations | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Area | | | Wt | WC | SBP | DBP | Pulse | BMI | WHR | WHtR |
| Rural | Wt | Pearson Correlation | 1 | | | | | | | |
| | | Sig. (2-tailed) | | | | | | | | |
| | WC | Pearson Correlation | .859** | 1 | | | | | | |
| | | Sig. (2-tailed) | .000 | | | | | | | |
| | SBP | Pearson Correlation | .430** | .343** | 1 | | | | | |
| | | Sig. (2-tailed) | .000 | .000 | | | | | | |
| | DBP | Pearson Correlation | .315** | .265** | .584** | 1 | | | | |
| | | Sig. (2-tailed) | .000 | .000 | .000 | | | | | |
| | Pulse | Pearson Correlation | .014 | .109* | .169** | .262** | 1 | | | |
| | | Sig. (2-tailed) | .768 | .020 | .000 | .000 | | | | |
| | BMI | Pearson Correlation | .127** | -.073 | -.139** | -.098* | -.049 | 1 | | |
| | | Sig. (2-tailed) | .006 | .119 | .003 | .036 | .297 | | | |
| | WHR | Pearson Correlation | .293** | .587** | .147** | .097* | .089 | .072 | 1 | |
| | | Sig. (2-tailed) | .000 | .000 | .002 | .039 | .059 | .127 | | |
| | WHtR | Pearson Correlation | .607** | .879** | .213** | .205** | .120* | -.051 | .618** | 1 |
| | | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .011 | .279 | .000 | |
| | | N | 455 | 455 | 455 | 455 | 455 | 455 | 455 | 455 |

**. Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed).

*Table 5: Correlation Matrix showing significant relationship between various risk factors*

Weight with WC, WHtR, SBP, DBP, WHR showed highly significant positive correlation (p<0.001) and BMI (p =0.006). In a similar way, WC with SBP, DBP, WHR, and WHtR showed highly significant positive correlation (p<0.001) and with pulse rate (p<0.05). Identically, SBP with DBP, pulse rate and WHtR (p<0.001) and with WHR (p<0.01) while with BMI, a significant negative correlation (r= **-**.139**;**p< 0.01) was observed.

Pulse rate and WHtR showed highly significant positive correlation (p<0.001) with DBP and with WHR (p<0.05); while negative correlation existed with BMI (r= -.098**;** p<0.05). WHtR and WHR had strong positive correlation (p<0.001) while pulse rate also has correlation with WHtR (p<0.01).

Among all the factors the study identified, BMI showed the least correlation with risk factors whereas weight showed highly significant correlation followed by WC, SBP, DBP, WHR and WHtR among the variables studied (*Table 5*).

| Variables | | Beta Coefficient | p- value | Model significance | p-value |
|---|---|---|---|---|---|
| Systolic BP | BMI | -.085 | .046* | 53.848 | .000*** |
| | Weight | .419 | .000*** | | |
| Diastolic BP | Weight | .315 | .000*** | 49.979 | .000*** |
| Pulse rate | Diastolic BP | .262 | .000*** | 33.433 | .000*** |

*Table 6: Stepwise Linear Regression Model showing predictive values with BP& pulse (N=455)*
**** Highly significant at p<0.001*

A stepwise linear regression analysis was done with pulse and blood pressure (systolic and diastolic) as dependent variables and study variables at (Wt, BMI, WHR, WHtR and WC) were entered in to the model. Regression analysis indicated weight alone was predictive ofsystolic and diastolic BP in adolescents from rural areas. BMI was found to be predictive of systolic BP; while diastolic BP was found to be predictive of pulse rate (Table 6).

**5. Summary**

Thestudy of 455 adolescents from two rural communities in Kerala was done to explore the prevalence of cardio metabolic risk factors, its correlates and association with demographic variables.The study highlighted substantial number of adolescents having high risk for cardio metabolic disorders associated with overweight and obesity in rural Kerala.

Nearly half (34.1%) of the female subjects were overweight by their WHR values; 7.6% having visceral obesity by WC and WHtR values. General obesity in (2.1%) and visceral obesity in 4.1%besides pre hypertension andhypertension were seen more in males compared to females. Weight was a highly significant risk indicator; and the single most predictive ofsystolic and diastolic blood pressure. Sizeable segment of adolescent population in rural Kerala are at risk for cardio metabolic disorders. More females were

found to be at risk categories (34.1% with WHR > 0.81; 7.6% with WC >81cm; and 7.6% with WHtR >0.51). Religion showed significant association with BMI ($p<0.05$), gender with WHR ($p<0.001$) and fathers' occupation with BMI and WHtR ($p=0.005$). Family, particularly the paternal role is pivotal in reshaping the lifestyle of adolescents in rural Kerala to ensure cardio metabolic risk reduction.

**6. Discussion**

*An exploratory study on prevalence of cardio meatbolic risk factors was conducted among 455 adolescent children studying in 9th Std of 9 schools located in rural areas of two selecetd districts in Kerala by multistage random sampling.*

*In accordance with national and international observations, evidence for increasing prevalence of overweight and obesity was visible among schoolgoing children in adolescence.*

Present study among high school students had corresponding findings, but less (high waist circumference (WC) (7.6%), obesity among males (2.1%) and high Systolic BP (SBP) (7.25%) and DBP (3.74%).However, prevalence of overweight in females (34.1%) was higher in the present study of younger age group.

Cherian AT (2011) in a study of 1634 children in 6-15 year age group from urban Kerala reported obesity prevalence among boys at 3.0%and girls at 5.3%. Subjects from high income group have high prevalence of overweight (21.9%) and obesity (7.5%) compared to those from lower income group (1.5% and 2.5%).Overweight and obesity were more among girls from high income group. Findings from across sectional study of 144 first year medical students found high prevalence of cardio vascular risk factors; high waist circumference (WC) 23%, overweight (12%), obesity(12%), high Systolic Blood Pressure (SBP) (10%) and high Diastolic Blood Pressure (DBP) (21%); risk seen more among females (77%) compared to males(73%) (Kurian S, 2015).

The high prevalence of overweight among girls is intimidating as the implications for the future generations will be serious. The findings call for preventive steps at school and community level involving parents, teachers, policy makers and children through health awareness programs. This public health issue needs to be tackled on a war footing at a time when the risk factors are amenable to primary prevention rather than secondary prevention.

Management should involve enhancement of physical activities, restriction of sedentary activities like watching TV and internet surfing, and management of dietary habits with avoidance of high calorie foods. Food habits should involve healthy snacks with natural fiber from adequate intake of fruits, vegetables and wholegrain cereals. Reduction of salt, fat, and sugar rich foods and beverages should be inculcated in to dietary habits. Parents play important role in cultivating good dietary habits.

In current study, weight showed highly significant correlation followed by WC, SBP, DBP, WHR and WHtR ($p<0.001$) whereas BMI showed least correlation ($p=0.006$) with risk factors. Significant positive correlation between Body Mass Index (BMI), WC with lipid parameters and BP was reported in a study of medical students (Kurian S, 2015).

**7. Conclusion**

Presence of cardio metabolic risk factors associated with overweight and obesity are prevalent among school going children, particularly girls in their early adolescence even in rural areas of Kerala. These findings are daunting as the implications paint a grim picture for future generations. The possibility of reversing the phenomenon should be utilized with utmost prudence when it is viable.

**8. Limitations**

The study is limited to adolescents from two districts of central Kerala among rural community; hence generalization to represent with the rest of the state or country is limited.

**9. Recommendations**

Irrespective of socio economic status, individual of all ages including adolescents and children should maintain body weight appropriate for height. Parents should oversee the weight gain of children right from childhood and encourage physical activity and curtail sedentary activities.


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