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Prevalence of Overweight, Obesity and Metabolic Abnormalities Among 12-15 Year Age Group in an Urban City in Sri-Lanka

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Abstract

Objectives: To determine the prevalence of childhood overweight, obesity and metabolic abnormalities among children aged 12-15 years within the schools in Kandy Municipality area, Sri Lanka.

Design: Cross- sectional descriptive study.

Setting: Schools in Kandy municipality area

Methods: The anthropometric measurements of 1766 school children were taken and those who were overweight or obese were recruited for evaluation of metabolic abnormalities. Overweight and obesity were defined according to the WHO standards.

Results: There were 1053 (59.63%) boys and 713 (40.37%) girls of whom 258 (14.60%) were either overweight or obese (7.81% overweight and 6.79% obese). Central obesity was seen in 299 (16.93%) and 88 (5.01%) of them had normal body mass index. Eighty-five children out of the 258 with body mass index > 1 SD reported for further evaluation and the prevalence of metabolic syndrome among this sub group was 11.67% (5 girls and 5 boys). When borderline and abnormal levels of lipids were taken together, more than 50% of overweight and obese children were found to have dyslipidaemia. Elevated Alanine Amino Transaminase and Aspartate Amino Transaminase levels were reported in 33 (38.82%) and 7 (8.24%) respectively. Evidence of fatty liver was present in 34.69% based on abdominal ultra sound scan findings.

Conclusion: While prevalence rates of overweight, obesity and metabolic syndrome are comparable with other urban settings in the country as well as neighbouring countries in Asia, the study highlights the detection of lipid abnormalities suggestive of familial hyperlipidaemia which warrants further evaluation. NAFLD is also identified as a significant comorbidity.

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INTRODUCTION

Childhood obesity has been increasing world-wide including South Asia [1]. A study on North-Indian urban children reported prevalence of overweight and obesity at 9.7% and 3.3% respectively [2]. According to a similar study conducted in Pakistan, 12% of school children were obese and 8% were overweight [3]. A study on primary school children of urban Nepal showed that 18.6% of children were overweight and 7.1% obese [4]. Prevalence of obesity and overweight among school-aged children in Bangladesh was respectively 3.5% and 9.5% [5].

A survey conducted in the Colombo district during 2004 to 2005 showed that the prevalence of obesity among boys and girls aged 5-15 years were 5.7% and 6.4% respectively [6]. A cross sectional descriptive study from Negombo, revealed that 27% of girls and 19% of boys aged 10-15 years were obese [7]. Prevalence of overweight and obesity were respectively 9.4% and 5.5% among teenage-girls in Batticaloa which in addition showed a 21.6% prevalence of central obesity [8]. Collectively, literature acknowledged that the prevalence of childhood obesity has been increasing over the time and shows a regional variation [6, 9].

The growing prevalence of obesity among Sri-Lankan children, particularly central obesity has led to the emergence of a constellation of metabolic derangements including dyslipidaemia, insulin resistance and non-alcoholic fatty liver disease (NAFLD) [8, 10, 11]. The link between central obesity, metabolic syndrome and type 2 diabetes is increasingly recognized in children [12]. The predominant dyslipidaemia pattern in childhood obesity, a combination of hypertriglyceridaemia and low high density lipoprotein cholesterol, together with central obesity, hyperglycaemia and hypertension represent a clustering of atherogenic risk factors described as metabolic syndrome [13]. The prevalence of metabolic syndrome in Colombo, Sri Lanka was 1.6% and 22.1% of them were obese [14]. NAFLD is a potential cause of chronic liver disease [15] and it's prevalence was recently studied in Ragama Medical Officer of Health area reporting 8.4% in adolescents[10].

The prevalence of childhood obesity, overweight and metabolic syndrome has not been adequately studied in Kandy which is one of the highly populated urban cities in Sri Lanka. Thus, our objective was not only to estimate the prevalence of overweight, obesity and central obesity among children aged 12-15 years (Grade 8, 9 and 10) attending the schools in Kandy Municipality area, but also to explore the prevalence of metabolic abnormalities and non-alcoholic fatty liver disease among overweight and obese.

METHODS

This cross-sectional descriptive study was conducted in selected schools from November 2018 to June 2019. The study population was pupils between the ages of 12 to 15 years studying in schools situated within the Kandy Municipal council area. Minimum sample size required for the study was 456 considering the prevalence of obesity as 5% (precision 0.02, confidence-level 95%)[16]. To accommodate design effect due to cluster sampling step involved in the multistage sampling strategy, sample size was doubled and inflated by 10% for contingencies. Final minimum sample requirement was 1004. Cluster size was pre-determined as 20 and the number of clusters was 50.

Sampling

In stage 1, a 20% sample (n=14) from the type 1AB, 1C and type 2 government schools (n=70) in the Kandy municipality area was selected using stratified random sampling method, proportionate to the population. In stage two, cluster sampling was used to select 50 clusters of 20 pupils. All grade 8, 9 and 10 classes from the selected schools were listed where each class was a cluster and 50 clusters were selected through simple random

sampling. The cluster size of 20 was decided since many classes in type 2 schools have less number of students.

Ethical Consideration

Ethical approval (2018/EC/30) was obtained from the Ethical Review Committee, Faculty of Medicine, University of Peradeniya. Written permission was taken from the Zonal Education Office, Kandy. Written informed consent to participate was obtained from all the respondent parents and school authority before data collection.

Data collection

Body weight was measured to the nearest 0.1 kg using a pre-calibrated OMRON (HBF 510W) body composition monitor and height was quantified to the 0.1 cm using the GIMA portable stadiometer. Waist circumference was measured with a flexible measuring tape with the subject standing upright, feet slightly apart and abdomen relaxed. Waist circumference was taken at the narrowest point of the torso above the umbilicus and below the rib cage [17]. Body fat percentage was measured by OMRON (HBF 510W) body composition monitor using the Bioelectrical Impedance Analysis technique.

Participants whose Body Mass Index BMI-for-age was greater than 1 standard deviation above the WHO Growth Reference median; and greater than 2 standard deviations above the WHO Growth Reference median were recruited to examine the presence of metabolic syndrome [18]. Subjects whose BMI was above 1SD were requested to undergo blood investigations and USS abdomen at the Research laboratory of Faculty of Medicine, University of Peradeniya. Written instructions as well as telephone advice were given to parents. USS were performed by a single consultant radiologist.

Their blood samples were analysed using fully automated Biochemical analyser (HumaStar 150 SR-Human) for fasting lipid profile, fasting blood sugar, and liver enzymes (Alanine Amino Transaminase and Aspartate Amino Transaminase). Internal and external quality control procedures are regularly carried out on the tests that were performed.

Real-time ultrasonography of abdomen was done utilizing Toshiba TUS-A 300 Ultrasound Machine with 3.5 MHz convex transducer.

Metabolic syndrome was diagnosed according to International Diabetes Federation criteria [19]. Overweight and obesity were diagnosed based on BMI cut-offs of WHO [18]. Waist Circumference cut-offs by British growth standards were used since ethnic specific or regional cut-off are currently unavailable [20]. Percentages total body fat of 35% for girls and 25% for boys were considered as cut-off values for obesity related morbidity [21, 22].

Data analysis:

Data was analyzed using Microsoft Excel and SPSS version 20. The study sample is described with proportions/percentages and means with 95% confidence intervals. Cluster effect was assessed with mixed model analysis. Means were compared between school types adjusted by age to assess differences. Chi square test was used to determine the association of the presence of fatty liver with elevated liver enzymes.

RESULTS

Anthropometric measurements were taken in 1766 children who comprised of 1053 (59.63%) boys, 713 (40.37%) girls. Average BMI of the sample was 19.0 ± 7.0 kg/m^2 and mean waist circumference was 65.0 ± 9.3 cm. In the total sample, 258 (14.60%) were overweight or obese.
Mixed model analysis indicated that no significant cluster effect was present between the schools (intercept was redundant- data not shown). A significant difference was observed by school type in the age adjusted mean BMI of boys where lowest was observed among students of type 2 schools (Table 1). Mean BMI by age categories indicated a significant difference with the highest among the oldest category as expected. Prevalence of overweight (+1SD) was 138 (7.81%) and prevalence of obesity was 120 (6.8%). This included 106 girls of whom, 64 (8.98%) were overweight and 42 (5.89%) were obese and 152 boys of whom, 74 (7.03%) and 78 (7.41%) were overweight and obese respectively. (Table 2).

Table 1. Age adjusted mean BMI with 95% CI for boys and girls by school type

Sex	School type	Mean	95% Confidence Interval	
			Lower Bound	Upper Bound
Boys[a]	1AB	18.6	18.3	18.9
	1C	18.3	17.9	18.7
	2	16.7	15.9	17.6
Girls[b]	1AB	19.6	19.2	19.9
	1C	18.8	18.0	19.6
	2	18.2	17.2	19.2

a. Covariates appearing in the model are evaluated at the following values: Age = 13.6010.
b. Covariates appearing in the model are evaluated at the following values: Age = 13.5504.

There is a difference of the mean BMI values of the boys in type 1 schools and type 2 schools as shown in Table 1.

Table 2: Age adjusted mean BMI and Overweight (+1SD) and obesity (+2SD) proportions among school children by age categories according to WHO standards.

	Total	Mean (95% CI)	Overweight /obese (+1 and +2SD) N (%)	Overweight N (%)	Placement of N (%)
Girls					
12-13 Years	253	18.5(18.0-19.0)	39 (15.4)	23 (9.1)	16 (6.3)
>13-14 Years	267	19.4(18.9-19.8)	36 (13.4)	21 (7.9)	15(5.6)
>14-15 Years	193	20.0(19.2-20.7)	31(16.1)	20 (10.4)	11(5.7)
Total	713	19.3(18.9-19.6)	106 (14.9)	64 (9.0)	42(5.9)
Chi square p values			.711	.012*	.932
Boys					
12-13 Years	345	17.8(17.4-18.2)	48 (13.9)	22(6.4)	26(7.5)
>13-14 Years	407	18.3(17.9-18.7)	57(14.0)	25(6.1)	32(7.9)
>14-15 Years	301	18.8(18.4-19.2)	47(15.6)	27(9.0)	20(6.6)
Total	1053	18.3(18.1-18.5)	152(14.4)	74(7.0)	78 (7.4)
Chi square p values			.000*	.296	.785
Girls and boys					
12-13 Years	598	18.1(17.8-18.4)	87(14.6)	45 (7.5)	42(7.0)
>13-14 Years	674	18.7(18.4-19.0)	93 (13.8)	46(6.8)	47(7.0)

>14-15 Years	494	19.2(18.9-19.6)	78(15.8)	47(9.5)	31(6.3)
Total	1766	18.7(18.5-18.9)	258(14.6)	138(7.8)	120 (6.8)
Chi square p values			.635	.227	.863

*Significant p value

Total body fat percentages in overweight or obese children (152 boys, 106 girls), which revealed 78 (51.32%) boys and 92 (86.79%) girls were beyond the cut-off values for their gender.

Central obesity defined as waist circumference above 90th percentile according to the British standards was seen in 299 (16.93%) of the total population and 76(5.04%) of them had normal BMI. Among the group of overweight and obese children (n=258), 223 (86.43%) had waist circumference above 90th percentile.
Out of the 258 children who were overweight or obese, only 85 (32.9%) children reported for blood investigations. The prevalence of metabolic syndrome was 11.8% (5 girls and 5 boys) was found in this group of children. Waist circumference above 90th percentile, fasting blood sugar ≥ 100 mg/dl, high density lipoprotein ≤ 40 mg/dl and triglycerides ≥ 150 mg/dl were seen in 71 (83.5%), 8 (9.4%), 25 (29.4%) and 21 (24.7%) respectively. All participants were normotensive.

Acceptable, borderline and abnormal levels in the fasting lipid profiles were defined as per cut-offs provided by American College of Cardiology [23] and proportions of children in each category are shown in Table 3. A considerable number of children in our sample had high levels of cholesterol, triglycerides, low density lipoprotein and low levels of high density lipoprotein.

Table 3: Lipid patterns of children with metabolic syndrome (n=85).

	Acceptable	**Borderline**	**Abnormal**
Total cholesterol (TC)	41 (48.24%)	19 (22.35%)	25 (29.41%)
Reference Range TC (mg/dL)	<170	170-199	≥200
Triglycerides	22 (25.88%)	35 (41.18%)	28 (32.94%)
Reference Range Triglycerides(mg/dL)	<90	90-129	≥130
Low density lipoprotein cholesterol (LDL)	42 (49.41%)	20 (23.53%)	23 (27.06%)
Reference Range LDL (mg/dL)	<110	110-129	≥130
High density lipoprotein cholesterol (HDL)	28 (32.94%)	32 (37.65%)	25 (29.41%)
Reference Range HDL (mg/dL)	>45	40-45	<40

Elevated Alanine Amino Transaminase (>40IU/L) and Aspartate Amino Transaminase (>34IU/L) levels were reported in 33 (38.82%) and 7 (8.24%) respectively from the 85 children who underwent blood investigations [24].
Only 49 children reported for ultrasound scan of abdomen. Grade 1 fatty liver was seen in 14 (28.57%) while grade 2 fatty liver was seen in 3 (6.12%) [25]. From these children, 19 (38.78%) had elevated Alanine Amino Transaminase levels. All who had grade 2 fatty liver reported to have elevated Alanine Amino Transaminase. There was a correlation between elevated Alanine Amino Transaminase and the presence of fatty liver (p=0.04).

DISCUSSION

The study found that nearly one in seven school children (14.6%) aged 12-15 years in this urban Sri Lankan setting are either overweight or obese. The prevalence of overweight and obesity which were 7.81% and 6.8% respectively are in congruence with findings from other parts of the country [8]. However, neighbouring countries like Pakistan and Nepal report a higher prevalence of overweight [3, 4]. This contrast in the findings could be attributed to the slight variation in the age range of the study populations.

The study revealed a prevalence of metabolic syndrome among overweight and obese children at 11.76% which is congruent with the findings from other urban settings of the country [14]. The prevalence of metabolic syndrome among Sri-Lankan adolescents is significantly lower compared to obese adolescents in India [26]. However, underweight and stunting show a significant prevalence in rural communities as reported by Naotunna etal. [27]

Waist circumference above 90th percentile was found at a prevalence of 86.43% of the overweight and obese population surfacing the increased metabolic risk in this age group. The waist circumference was interpreted according to the British standards since country specific nomograms are unavailable. Waist circumference could vary among diverse ethnic groups [28, 29]. International Diabetes Federation, recommends using ethnic specific waist circumference charts where available. Waist circumference cut-offs outlined in a cohort of urban Sri Lankan children, identified 43.88% of central obesity in our total study population while British waist circumference cut-offs detected only 16.93% [21]. Hence there is a potential for both cut-offs to either over estimate or under estimate central obesity in Sri Lankan children. Therefore, further studies from different areas of the country would be useful to determine waist circumference standards for Sri-Lankan children.

Hypertriglyceridemia and low high density lipoprotein cholesterol levels in the abnormal range were found in one in three overweight children. However, fasting blood sugar was abnormal only in 9.41% and none were hypertensive. These findings, while demonstrating a contrasting difference in the prevalence of different metabolic risk factors, highlights the abundance of central obesity with dyslipidemia in this urban child population.

The lipid pattern in this overweight & obese cohort, when borderline and abnormal cut-offs taken together revealed adiposity related dyslipidemia pattern (high triglycerides with low high density lipoprotein cholesterol) in more than two third. The prevalence of high cholesterol levels and high low density lipoprotein cholesterol levels were found in nearly 50% of this population thus surfacing the possibility of the existence of familial hyperlipidemia in addition to adiposity related dyslipidaemia. Further studies are needed to identify the lipid pattern in Sri Lankan child population. Even though NAFLD was detected in 34.69% it is difficult to derive significance due to under reporting for ultra sound scan procedure which could be attributed to lack of awareness among general public regarding obesity and its implications.

Poor response rate of over weight and obese children for blood investigations was a significant limitation in our study which affects application of the prevalence of metabolic syndrome to a larger population. Students may not have handed over the request letters to their parents. Lack of awareness among parents and children regarding the negative impact of overweight on health might be attributed to this less response rate.

CONCLUSION

Overweight and obesity prevails at 14.6% among the children aged 12-15 years in this urban area which are comparable with the prevalence rates reported from similar urban settings in the island. Metabolic syndrome was prevalent at a rate of 11.67%. Presence of central obesity in 5.04% among children with normal BMI implies that the prevailing BMI cut-offs may under estimate adiposity in Asian ethnicities. Presence of elevated low density lipoprotein cholesterol in 27.06% is an eye-opener as to the existence of familial

hyperlipidaemia in addition to adiposity related dyslipidaemia.

Findings of this study contribute to the national data base of the non-communicable disease prevention programme and assimilation of data from different parts of the country would prompt the concerned stakeholders to develop a strategic preventive programme. Further studies are recommended to determine the prevalence of central obesity, NAFLD and the dyslipidaemia pattern among Sri-Lankan children.

Abbreviations:
BMI: Body Mass Index
IOTF: International Obesity Task Force
NAFLD: Non Alcoholic Fatty Liver Disease
IDF: International Diabetes Federation
OW: Overweight
WC: Waist Circumference
TG: Triglycerides
MS: Metabolic Syndrome
FBS: Fasting blood sugar
ALT: Alanine Amino Transaminase
AST: Aspartate Amino Transaminase
HDL-C high density lipoprotein cholesterol
LDL-C: low density lipoprotein cholesterol

Author declaration

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Author Contributions
VK and CA conceptualized the study, VK, JR, RK, TM, UK, SA and MP collected the data, VK, RK, GV and TM analysed and interpreted the data, VK, RK and GJ drafted the manuscript, VK, ST and JU refined methodologies and tools, VK, MP, GV and RK revised the manuscript, VK, CA and JR finalized the manuscript. All authors read and approved the final manuscript.

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Availability pf data and materials
All data is available in the paper. The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate
Ethics approval for this study was obtained from the ethical review board of the Faculty of Medicine, University of Peradeniya. Written permission was taken from the Zonal Education Office, Kandy. Written informed consent to participate was obtained from all the respondent parents and school authority before data collection.

Competing interests
No conflicts of interest declared by the authors

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