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The prevalence and related factors of pre-diabetes and diabetes among overweight and obese children in Urban schools

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ABSTRACT

Objective: This study aimed to determine the prevalence of pre-diabetes and diabetes among overweight and obese children in urban schools and factors associated with them, in Batticaloa District, Sri Lanka.

Methods: A school based cross-sectional descriptive study was conducted to collect data on socio-demographic information, eating habits and physical activities, using a validated, pre-tested questionnaire. In addition, anthropometric measurements and glycosylated haemoglobin (HbA1c) test were performed. Multivariate logistic regression analyze was performed to identify the factors associated with glycemic status by using SPSS v23.

Results: Out of the 269 children recruited, 59% were obese. Prevalence of pre-diabetes (HbA1c 5.7%–6.4%) and diabetes (HbA1c ≥ 6.5%) were 20.1% (95% CI 15.5%–25.4%) and 3.3% (95% CI 1.5%–6.3%) respectively. Multivariate regression shows that having a BMI of ≥ 27.5Kg/m^2 (AOR=2.69), male gender (AOR=2.71) and ethnicity (AOR = 2.58) were found to be significant factors for higher HbA1c (≥5.7%).

Conclusions: Prevalence of prediabetes and diabetes among overweight and obese school children was high and mainly associated with body weight which is a modifiable risk factor. Lifestyle modifications focusing on weight reduction among overweight and obese school children especially boys, need to be carried out.

Keywords: Overweight, Obesity, Child, Prediabetic State, Glycated Hemoglobin A, Ethnic Groups

INTRODUCTION

The proportion of overweight and obesity among children and adolescents is increasing rapidly in developing countries specially in Sri Lanka.[1,2] The World Health Organization (WHO) report on obesity and overweight in 2021 showed that the global prevalence of obesity has nearly tripled since 1975. It further showed that in 2016, more than 1.9 billion adults (≥18 years) were overweight and of these over 650 million were obese. In 2020, 39 million children under the age of 5 were found to be overweight or obese[3]. At present, the increase in childhood obesity is an evolving concern in the developing nations and, it is expected that these nations would face heavy socio-economic and in public health burden in the near future.[4]

It is reported that childhood obesity is a common problem in Sri Lanka.[5] A Sri Lankan study con-

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ducted among urban children between 5-18 years showed a prevalence of obesity and overweight as 10.3% and 11.3% respectively.[6] Childhood obesity is the precursor of insulin resistance and dyslipidemia which are the key elements of metabolic syndrome among children that is rapidly increasing in Sri Lanka.[7] Behavioral changes seen over the recent past, such as consumption of diets with high fat and refined carbohydrates, increase in physical inactivity and sedentary behavior and target oriented education are factors contributing to the development of childhood obesity.[8] Obesity in turn affects children physically and psychologically and leads to the development of non-communicable diseases (NCDs) such as Type -2 diabetes mellitus (T2DM), hypertension, heart diseases, stroke, liver diseases, breathing problems and cancer.[9] Moreover, it has been reported that T2DM was observed among 80% of overweight and 60-90% of obese children.[10]

Overweight and obesity are defined by the Body Mass Index (BMI) and BMI remains the best method to measure adiposity.[11] In addition, use of Glycosylated hemoglobin (HbA1c) levels was recommended by the American Diabetes Association (ADA) for the screening of pre-diabetes in both children and adolescents.[12] HbA1c is a reliable biomarker which is utilized for estimating the glucose levels over the past three months.[13]

Overweight and obesity in children leads to the early development of T2DM. Thus, recognition of impaired glucose tolerance in these children is vital for interventional programmes. We could not find any reported studies on the prevalence of pre-diabetes and diabetes and its associated factors among overweight and obese school children in Sri Lanka, especially in Batticaloa district. Therefore, we aimed to determine the prevalence of pre-diabetes and diabetes among overweight and obese children and their related factors in urban schools in Batticaloa District, Sri Lanka.

METHODS

A quantitative cross-sectional descriptive study was conducted in advanced level students (grades 12 and 13) of thirteen 1AB category schools. Only 1 AB category school was selected in order to include all streams (Science, Mathematics, Commerce, Arts, Agriculture and Technology). All male and female overweight and obese students who were willing to participate in the study were included. Overweight and obesity were defined as a BMI of 23.0-27.4 kg/m^2 and ≥ 27.5 kg/m^2 respectively[14]. A total of 269 students were recruited in this study based on their BMI.

A validated, pre-tested questionnaire was used to collect the data on participants' socio-demographic information, dietary habits, and exercise details. The questionnaire was developed in English by the investigators and was validated through judgmental validity and content validity by a group of field experts. Back translation method was used to translate the questionnaire. The validated questionnaire was pre-tested among school children (1C school) who matched the inclusion criteria. A few modifications were made as needed. The translated Tamil version of the questionnaire was used to collect data.

In addition to socio-demographic information of participants, measurement of weight, height and waist and hip circumference were documented. Weight was measured using Seca beam scale, kilogram (Kg) up to the nearest 100 g with the participant wearing no shoes. Height was recorded in centimeter (cm). The participant was standing barefoot, with feet together, with head, shoulders, buttocks and heels touching the back of the stadiometer with the head facing straight parallel to the floor. At this point, the lower orbital margin and tragus kept in a single horizontal line. Measurement for height was taken to nearest 1cm. The participant' waist and hip circumferences were measured with a measuring tape while they were standing. Waist circumference was measured as the horizontal level at the midpoint between lower margin of costal margin and upper margin of iliac crest in the mid axillary line in standing position at the end of normal expiration with the tape parallel to the floor. Hip circumference was measured around the broadest part of the buttocks.

HbA1c was estimated from a venous sample of blood which was collected by a trained registered nurse. Fasting status was not considered as it was not indicated for estimation of HbA1c. HbA1c was measured by a NGSP certified method of high-performance liquid chromatography. Glycemic status was categorized based on HbA1c value as follows; HbA1c <5.7%- no diabetes (normal); 5.7%–6.4% - pre-diabetes and ≥ 6.5% - diabetes.[12] Further, any chronic disease status of the participant was identified and confirmed based on the diagnosis card issued by the hospital. In addition, regular sport activity was defied as 'student who regularly involved in any sport activity for 150 minutes or more per week'.

Data collection was conducted by trained data collectors under the supervision of researchers. Ethical approval for the study was obtained from the Ethic Review Committee, Faculty of Health-Care Sciences, Eastern University of Sri Lanka. An assent was obtained from who were ≤18 years and the written informed consent obtained from study participant who were ≥19 years prior to the data collection.

Data were analyzed using SPSS v 23. Percentage and mean of the variables were obtained using descriptive statistics. One-way ANOVA was used to assess the mean differences between three or more categorical variables after checking the normality distribution[15]. Statistically significant association was determined between glycemic status and other sociodemographic details using chi – square test. Chi-square and unadjusted odds ratio with their

95% confidence interval (95% CI) were used to check the significance of the differences observed. Univariate and multivariate analyzes were used to identify the factors associated with glycemic status. A p value of <0.05 was set as statistical significance.

RESULTS

The prevalence of pre-diabetes and diabetes were 20.1% (95% CI 15.5–25.4%) and 3.3% (95% CI 1.5–6.3%) respectively. Among the nine children (n=9) who had HbA1c levels in the diabetes range, two were already diagnosed with diabetes (Table 1).

Among all participants who had abnormal glycemic status (HbA1c ≥5.7%), about 65.1% of them were boys and they were nearly 3.7 times more likely to have abnormal glycemic status compared to the girls (OR 3.70, 95% CI= 2.04– 6.70). Similarly, participants with Muslim ethnicity were nearly 5.5 times more likely to have abnormal glycemic status compared to other ethnic groups (OR 5.49, 95% CI=2.99-10.09). In addition, participants who had BMI of ≥27.5 Kg/m^2 (OR 3.12, 95% CI= 1.62– 6.00) ate yam at more than one meal per day (OR 2.32, 95% CI= 1.24 - 4.37) and took sweets for dessert regularly after a main meal (OR 2.04, 95% CI= 1.00 – 4.13); and they were nearly three times, two times and two times more likely to have abnormal glycemic status compared to their counterparts respectively (Table 2).

Multivariate logistic regression was applied to control the confounding factors and to predict the variables associated with glycemic status of HbA1c ≥5.7%. Having had BMI of ≥ 27.5Kg/m^2 (AOR=2.69), being a boy (male gender) (AOR=2.71) and belong to Muslim ethnicity (AOR=2.58) were found to be statistically significant factors for having high HbA1c levels (≥5.7%). (Table 3)

Table 1: The prevalence of pre-diabetes and diabetes (n=269)

Glycemic status	Total n (%)
<5.7% (No Diabetes)	206 (76.6)
5.7 %–6.4 % (Pre- diabetes)	54 (20.1)
≥6.5 % (Diabetes)	9 (3.3)

Table 2: Factors associated with abnormal glycemic status of the study participants (n=269)

Factors	Abnormal glycemic status (HbA1c ≥ 5.7%) (n=63)	No Diabetes (HbA1c <5.7%) (n=206)	Unadjusted OR (95% CI)	p value
Gender				
Boys	41 (65.1)	69 (33.5)	**3.70 (2.04-6.70)**	**<0.005**
Girls	22 (34.9)	137 (66.5)		
Ethnic Background				
Muslim	42 (66.7)	55 (26.7)	**5.49 (2.99-10.09)**	**<0.005**
Other	21 (33.3)	151 (73.3)		
BMI category (Kg/m^2)				
≥27.5	49 (77.8)	109 (52.9)	**3.12 (1.62 -6.00)**	**<0.005**
<27.5	14 (22.2)	97 (47.1)		
Present Chronic disease				
Yes	11 (17.5)	32 (15.5)	1.15 (0.54-2.44)	0.72
No	52 (82.5)	174 (84.5)		
Permanent residence				
Urban	41 (65.1)	137 (66.5)	0.99 (0.52 -1.70)	0.83
Rural	22 (34.9)	69 (33.5)		
Living with				
Parents	59 (93.7)	200 (97.1)	0.44 (0.12-1.62)	0.21
Children home	4 (6.3)	6 (2.9)		
Family history of DM				
Yes	33 (52.4)	89 (43.2)	1.45 (0.82-2.55)	0.20
No	30 (47.6)	117 (56.8)		
Outside food				
No food	11 (17.5)	52 (25.2)	0.63 (0.30-1.30)	0.20
Main meal/Snacks	52 (82.5)	154 (74.8)		
Usage of wheat flour foods				
≥ 2 meals per day	12 (19.0)	27 (13.1)	1.56 (0.74-3.30)	0.24
1 meal per day	51 (81.0)	179 (86.9)		
Regular sport activities				
No	40 (63.5)	156 (75.7)	0.56 (0.31-1.02)	0.06
Yes	23 (36.5)	50 (24.3)		
Use of any Yams				
≥1 meal per day	47 (74.6)	115 (55.6)	**2.32 (1.24 – 4.37)**	**0.00**
Never	16 (25.4)	91 (44.2)		
Use of dessert after main meal (n=219)				
Sweets	33 (71.7)	96 (55.5)	**2.04 (1.00 - 4.13)**	**0.04**
Fruits	13 (28.3)	77 (44.5)		

Table 3: Binary logistic regression analysis model

Predictor variables	Coefficient (B)	Wald statistics	df	p value	AOR	95% CI
Age (years)	0.22	0.84	1	0.35	1.24	0.78– 1.97
Sweets as a dessert after meal	0.6	2.25	1	0.13	0.55	0.25 – 1.20
Living in an urban residence	0.24	0.35	1	0.55	1.27	0.57 - 2.82
Having yams ≥1 meal per day	0.33	0.67	1	0.41	0.72	0.36 – 1.58
BMI of ≥ 27.5Kg/m^2	1	4.95	1	**0.02**	**2.69**	**1.13 – 6.45**
Being a boy (male gender)	1	4.14	1	**0.04**	**2.71**	**1.04 – 7.00**
Muslim ethnicity	1.05	5.34	1	**0.02**	**2.85**	**1.17 – 6.94**

AOR – Adjusted odd ratio

DISCUSSION

This was the first survey conducted to determine the prevalence of pre-diabetes and diabetes among overweight and obese children in urban schools in Batticaloa District, Sri Lanka. In this study, the prevalence of diabetes and pre-diabetes in children with BMI of 23 kg/m^2 and over was 3.3% and 20% respectively, which shows that the risk of becoming diabetic from a pre-diabetic state is more in this group of children. Similarly, a cohort study conducted in the Emirati reported that 21.9% of children were found to have pre-diabetes.[16] Another study on screening obese children and adolescents for glucose intolerance and T2DM conducted in Portugal found that according to HbA1c, 32 obese children had pre-diabetes status and one had diabetes.[17]

However, in contrast, a prevalence of T2DM (HbA1c ≥ 6.5%) among obese school children was 0.5%[18] and was similar to values reported in few studies conducted in European countries.[19,20] In addition, a few studies conducted among children also have reported a low the prevalence of T2DM few decades ago.[21,22] It is clear that the prevalence of pre-diabetes and diabetes among children has been increased during the time. This rate of increasing prevalence of diabetes and pre-diabetes among children is influenced by various factors such increased prevalence of overweight/obesity, hypercholesterolemia, increased positive family history and sedentary lifestyle. Elevated insulin resistance in endothelial cells has been linked to the onset of T2DM, which is followed by compensated hyperinsulinemia.[23]

Pre-diabetes/diabetes status (HbA1c ≥ 5.7%) were identified particularly among boys, who had BMI of ≥ 27.5Kg/m^2 and who were Muslim ethnic group in the present study. Similarly, a study reported that boys have a higher prevalence of prediabetes than girls.[24] However, a study conducted by Kleber et al (2010) reported that there is no gender difference.[25] This difference could be explained that higher percentage of boys live in urban residents and had a more family history of diabetes than girls. Although the number of girls with overweight and obesity was more, the boys had a significantly higher number of abnormal HbA1C values. This is in contrast to the findings in the adult population where the incidence of diabetes is higher in women. This may indicate that females are at less risk during their adolescent period and the risk increases with age. However, further studies are required to identify the reason for increased risk in later life.

Further, study indicated that BMI of ≥ 27.5Kg/m^2 is associated with pre-diabetes/diabetes. Similarly, a few studies reported a positive relationship between body weight and the glycemic status.[26,27] Obesity has been linked to lower glucose tolerance, changes in glucose-insulin balance, insulin metabolic clearance, and insulin-stimulated glucose disposal.[28] Hence, lifestyle changes such as physical activity and healthy eating must be promoted among young schoolchildren in order to maintain a normal body weight, which lowers the risk of cardiovascular disease and metabolic problems later in life.[29]

In addition, children from the Muslim community had significantly higher abnormal HbA1C values and which was significantly associated with pre-diabetes/diabetes status. According to the American Diabetes Association, Hispanic ethnic groups have a twofold higher chance of acquiring T2DM than other demographics.[30] Further, it was noted in a another study that ethnic disparities among the HbA1c groups are significant.[31] However, Lee et al. (2011) found no statistically significant difference between glycemic status and ethnic groupings in a study of overweight or obese children.[32] Since all children in this study are from the same geographical region, further studies in dietary habits and genetic mutation in this population need to be conducted.

CONCLUSIONS

Prevalence of prediabetes and diabetes among overweight and obese school children was high and mainly associated with modifiable risk factor of body weight. Thus, lifestyle interventions focusing on weight reduction through sport activities and healthy eating should be carried out among overweight and obese school children in order to prevent premature development of T2DM.

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REFERENCES

1. Gunawardana S, Gunasinghe CB, Harshani MS, Seneviratne SN. Physical and psychosocial quality of life in children with overweight and obesity from Sri Lanka. BMC Public Health 2021; 21. https://doi.org/10.1186/s12889-020-10104-w
2. Sathiadas MG, Antonyraja A, Viswalingam A, Thangaraja K, Wickramasinghe VP. Nutritional status of school children living in Northern part of Sri Lanka. BMC Pediatr. 2021 Jan;21(1):43. doi:10.1186/s12887-021-02501-w
3. World Health Organization. Obesity and overweight; 2021 [cited 2021 August 22]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
4. Di Cesare M, Sorić M, Bovet P. et al. The epidemiological burden of obesity in childhood: a worldwide epidemic requiring urgent action. BMC Med 2019; 212.
5. Prevention of Overweight and Obesity among School Children in Sri Lanka 2018. Family Health Bureau Ministry of Health, Nutrition and Indigenous Medicine. [cited 2021 August 03]. Available from: http://fhb.health.gov.lk/images/FHB%20 resources/School%20Health/Publication/Obesity%20Guide%20English%20.pdf,
6. Wickramasinghe VP, Katulanda P, Seneviratne SN, Wijewickrama ES, Katulanda G, de Silva PHIU. Prevalence of obesity related metabolic abnormalities among 5-18-year-old children: Preliminary data from the Western Province of Sri Lanka. In. 22nd Annual Scientific Congress of Sri Lanka College of Pediatricians. Colombo: Sri Lanka College of Pediatricians; 2019. p. 81–2.
7. Wickramasinghe VP, Arambepola C, Bandara P, Abeysekera M, Kuruppu S, Dilshan P, Dissanayake BS. Distribution of obesity related Metabolic Markers among 5-15 year old children from an urban area of Sri Lanka. Annals of Human Biology.2013;40
8. Wickramasinghe VP. Management of Childhood Obesity: A rational approach. Journal of the Postgraduate Institute of Medicine 2015; 2:E22:1-5 doi: http://dx.doi.org/10.4038/jpgim.8084
9. Nedeltcheva AV, Kilkus JM, Imperial J, Schoeller DA, Penev PD. Insufficient sleep undermines dietary efforts to reduce adiposity. Annual International Journal of Medicine 2010; 153 (7): 435-41.
10. Safrida EN, Nurani N, Julia N. HbA1c, waist circumference, and waist-to-height ratio in overweight and obese adolescents. Paediatr Indones 2017; 57(2).
11. Saaddine JB, Fagot-Campagna A, Deborah Rolka, Venkat Narayan KM, Linda Geiss, Eberhardt M, Flegal KM. Distribution of HbA_{1c} Levels For Children and Young Adults in the U.S. Diabetes Care 2002; 25 (8):1326-1330.
12. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Standards of Medical Care in Diabetes, Diabetes Care 2019;42 (Suppl 1):S13–28.
13. Khan HA, Ola MS, Alhomida AS, Sobki SH, Khan SA. Evaluation of HbA1c criteria for diagnosis of diabetes mellitus: a retrospective study of 12785 type 2 Saudi male patients. Endocr Res. 2014;39:62–6.
14. World Health Organization Expert Consultation. Appropriate Body Mass Index (BMI) for Asian populations and its implication for policy and intervention strategies. Lancet 2004; 363: 157–163
15. Kim HY. Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis. Restor Dent Endod. 2013;38(1):52–54. doi:10.5395/rde.2013.38.1.52
16. Al-Amiri1 E, Abdullatif M, Abdulle A, Al Bitar N, Afandi EZ, Parish M and Darwiche G. The prevalence, risk factors, and screening measure for prediabetes and diabetes among Emirati overweight/obese children and adolescents. BMC Public Health 2015; 15:1298
17. Galhardo J, Shield J. The Role of Haemoglobin A1c in Screening Obese Children and Adolescents for Glucose Intolerance and Type 2 Diabetes. Acta Med Port 2015;28(3):307-315
18. Holst-Schumacher I, Nuñez-Rivas H, Monge-Rojas R, Barrantes-Santamaría M. Insulin Resistance and Impaired Glucose Tolerance in Overweight and Obese Costa Rican Schoolchildren. Food and Nutrition Bulletin 2008; 29(2):123–131.
19. Gunger N, Hannon T, Libman I, Bacha F, Arslanian S. Type 2 diabetes mellitus in youth: The complete picture to date. Pediatr Clin North Am 2005;52:1579–1609
20. Ehtishan S, Hattersley AT, Gunger DB, Barret TG. First UK survey of pediatric type 2 diabetes and MODY. Arch Dis Child 2004; 89:526–529.
21. Wei JN, Sung FC, Lin CC, Lin RS, Chiang CC, Chueng LM. National surveillance for diabetes mellitus in Taiwanese children. JAMA 2003; 290:1345-50.
22. Asha Bai PV, Krishnaswami CV, Chellamariappan. M, Vijaikumar G, Subramanian JR, Srivatsa A, et al. Prevalence of diabetes in south India. Indian Pediatr.1995; 32:1173-6.
23. Wilcox G. Insulin and Insulin Resistance. Clin Biochem Rev 2005; 26(2): 19–39.
24. Nguyen QM, Srinivasan SR, Xu J-H, Chen W, Berenson GS. Changes in risk variables of metabolic syndrome since childhood in pre-diabetic and type 2 diabetic subjects: the Bogalusa Heart Study. Diabetes Care 2008; 31: 2044-2049.
25. Kleber M, de Sousa G, Papcke S, Reinehr T. Risk factors for impaired glucose tolerance in obese children and adolescents World J Diabetes 2010; 129-134.
26. Nogueira-de-Almeida CA and Mello ED. Correlation of BMI Z-scores with glucose and lipid profiles among overweight and obese children and adolescents. J Pediatr (Rio J). 2018; 94:308-312.
27. Babikr WG, Alshahrani AS, Hamid HG, Abdelraheem AH, Shalayel MH. The correlation of HbA1c with body mass index and HDL-cholesterol in type 2 diabetic patients. Biomed Res 2016;27(4):1280-3.
28. Vazquez G, Duval S, Jacobs DR Jr, Silventoinen K. Comparison of body mass index, waist circumference, and waist/hip ratio in predicting incident diabetes: a meta-analysis. Epidemiol Rev. 2007;29:115-128.
29. Saydah S, Bullard KM, Imperatore G, Geiss L, Gregg EW. Cardiometabolic risk factors among US adolescents and young adults and risk of early mortality. Pediatrics. 2013;131:e679-86.
30. American Diabetes Association. Type 2 diabetes in children and adolescents. Pediatrics 2000;105:671–680.
31. Nowicka P, Santoro N, Liu H, Lartaud D, Shaw MM, Goldberg R et al. Utility of Hemoglobin A1c for Diagnosing Prediabetes and Diabetes in Obese Children and Adolescents. Diabetes Care 2011; 34 (6): 1306-1311.
32. Lee JM, Gebremariam A, Wu EL, LaRose J, Gurney JG. Evaluation of non-fasting tests to screen for childhood and adolescent dysglycemia. Diabetes Care. 2011; 34:2597-602.