Enferm Clin. 2020;30(S2):49–54

Enfermería Clínica

www.elsevier.es/enfermeriaclinica

Prediabetes among overweight and obese school-aged children: A cross-sectional study☆

Kadek Ayu-Erika[a,*], Arnis Puspitha[b], Ilkafah[c], Syahrul Syahrul[b]

[a] Department of Pediatric Nursing, Faculty of Nursing, Hasanuddin University, Indonesia
[b] Department of Community and Family Health Nursing, Faculty of Nursing, Hasanuddin University, Indonesia
[c] Department of Medical-Surgical Nursing, Faculty of Nursing, Hasanuddin University, Indonesia

Received 29 May 2019; accepted 15 July 2019

KEYWORDS
Prediabetes;
Lifestyle;
HbA1c level;
Children;
Overweight;
Obesity

Abstract
Objective: This study aims to determine the description of prediabetes events in children based on socio-demographic, anthropometric, and lifestyle characteristics.
Method: This cross-sectional study involved 110 school-aged children and their parents. Physical Activity Questionnaire for Older Children (PAQ-C) was used to examine children's physical activity, HbA1c measured to evaluate diabetes status, and feeding behavior questionnaire is given to students and through interviews.
Results: Prevalence of overweight and obese children who have an HbA1c level between 5.2% and 5.6% was 62.7%. Obese and overweight children are less support from family 72.2%, exercise once a week 82.7% with duration less than 60 min 68.2%, the habit of snacking 64.5%, and consumption of fast food ≥ two times a week 62.7%.
Conclusion: Socio-demographic, cultural family, and lifestyle play a role in increasing the risk of incident prediabetes in overweight and obese children of school age.

Introduction

Global data from 183 countries from 1980 to 2013 showed an increased prevalence of overweight and obese children higher than adults, namely 47.1% in children and 27.5% in adults. The prevalence of overweight and obese children (aged 2–19 years) in developing and developed countries has experienced an increase.[1] In 2014 it was estimated that 41 million children under five years were obese. In the

☆ Peer-review under responsibility of the scientific committee of the International Conference on Women and Societal Perspective on Quality of Life (WOSQUAL-2019). Full-text and the content of it is under responsibility of authors of the article.

* Corresponding author.
E-mail address: kadekayu@unhas.ac.id (K. Ayu-Erika).

https://doi.org/10.1016/j.enfcli.2019.07.029
1130-8621/

United States, more children aged 6 to 11 years old are obese (17.5%) compared to children aged 2 to 5 years old (8.9%) from 2011 to 2014.[2] In Indonesia, obesity also has high prevalence.[3] The prevalence of obesity in children aged 5–19 years has increased from 1999 to 2004, namely obesity from 5.3% to 8.6%, while overweight from 2.7% to 3.7% based on CDC standard cut-offs.[4] Data from the Ministry of Health of the Republic of Indonesia in 2013 showed that children aged 5–12 years are an overweight problem by 18.8% consisting of category 10.8% overweight and 8.8% obese, and experiencing the thinness of 11.2% comprising 7, 2% thin and 4.0% very thin.[5-7]

Rapid lifestyle changes, namely excessive eating patterns and physical activity, are less likely to cause an increase in the prevalence of overweight and obese children.[3,8] Increased of overweight occurs more in children of school age who are in urban areas.[5] Obesity in childhood can increase the risk of early death and disability in adulthood.[9] Severe obesity or long-term obesity can lead to serious medical conditions, including coronary heart disease, type 2 diabetes mellitus, several types of cancers such as endometrial, breast, or colon cancer, hypertension, cholesterol, liver failure, and so on.[10,11] Obesity is influenced by several factors such as poor diet, physical activity, limited sleep, genetic factors, even illness or drugs.[11] Factors that affect the occurrence of obesity that cannot be modified are genetic, ethnic, gender, and age while the factors that can be modified are nutrition intake and physical activity.[12]

Obese children diagnosed with TGT are prediabetic stadiums that should undergo a prevention program with lifestyle improvements and healthy bodyweight.[13] Interrupted Glucose Tolerance shows the presence of diabetes in the early stages and asymptomatic. They are not classified as sufferers of diabetes but are considered to have a higher risk of diabetes.[14] Lifestyle has been shown to play a role in the incidence of prediabetes through obesity.[15] Hemoglobin A1c (HbA1c) is recommended as a diagnostic tool for identifying DM and subjects at risk of developing Diabetes Mellitus (DM),[16,17] and HbA1c is a perfect predictor in identifying diabetes risk in children and can be used to identify prediabetes in children.[18]

The study of overweight and obesity among children is critical because most of the culture and perception of Indonesia stated that a fat child is a healthy child so that the family does not become aware that the impact of obese could cause a high risk to school-aged children.[19] Meanwhile, parents do not know HbA1c as a screening tool to identify prediabetes risks early on. Besides, studies of obese children associated with HbA1c levels in Indonesia were very lacking. Therefore the researchers aimed to determine HbA1c levels among overweight and obese school-aged children, and explore their lifestyles.

Methods

This was a cross-sectional study in four elementary schools in Makassar from July to September 2017. A total of 110 students (49 overweight and 61 obese students) aged 6–13 years old, along with their parents participating in this study were selected using quota sampling. Measurements of body weight and high, how to interview and fill out questionnaires were carried out by a trained team of 12 nurses. Assessment of children's nutritional status based on BMI-for-age (5–19 years) using WHO Anthroplus 2007.[20] Children with BMI z-score 1.00 SD to +2.00 SD indicated overweight, while BMI z-score 2.00 SD or more were classified as obese. Then the children were given a questionnaire and interviewed to explore family culture, behavior/eating habits of children, and behavior of children's physical activity. Instruments of physical activity using the Physical Activity Questionnaire for Older Children (PAQ-C).[21]

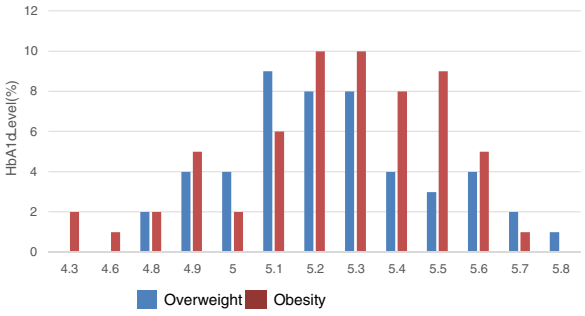

Figure 1 HbA1c level among overweight and obese children ($n = 110$).

The HbA1c examination using the international standardized method by the National Glycemic Hemoglobin Standardization Program (NGSP) with a cut-off diagnosis was 6.5% or more as an indication of diabetes, and 5.7–6.4% indications of prediabetes. Data were analyzed using frequency distribution of HbA1c levels based on overweight and obese children and cross-tabulation between socio-demographic, cultural, and lifestyle variables with normal HbA1c levels and prediabetes using the chi-square test and Pearson correlation test. The ethical clearance approved form Faculty of Medicine, Hasanuddin University (Number: 460/H4.8.4.5.31/PP36-KOMETIK/2017). Informed consent was obtained from the child and parents.

Results

Boys consist of 68 while girls are 42. Fig. 1 shows HbA1c levels in overweight children who had the lowest HbA1c level of 4.8% in 2 children (50%) and the highest HbA1c level in 5.8% in 1 child. There were four children in the prediabetes category with an HbA1c level of 5.7% as many as three children (2.7%) and level 5.8% as many as one child (0.9%). The most obese children data had 5.2% HbA1c and 5.3% respectively. Whereas most overweight children had 5.1% HbA1c levels of 9 children.

Table 1 shows the cross-tabulations between socio-demographics of children and parents. Children with prediabetes were four children (3.6%) where more boys were compared with girls who had prediabetes, namely three boys (2.7%) and one girl (0, 9%). All children who have prediabetes are in the 10–13 years old age range. Most of the prediabetic children come from high family income and those whose father's education are high.

Table 2 shows that the average HbA1c level in obese and overweight children is 5.23%. The average age of the child is 9.29 years old, bodyweight is 41.87 kg, body height

Table 1 Cross-tabulation between socio-demography characteristics of children and parents with children's HbA1c level ($n = 110$).

Variable	*n*	HbA1c Level[c]				*P*[d]
		Normal		Prediabetic		
		n	%	*n*	%	
Children's gender						1.000
Boy	68 (61.8%)	65	59.1	3	2.7	
Girl	42 (38.2%)	41	37.3	1	0.9	
Children's age						0.055
6–9 years old	56 (50.9%)	56	50.9	0	0	
10–13 years old	54 (49.1%)	50	45.5	4	3.6	
Father's education[a]						0.321
Low education	10 (9.1%)	9	8.2	1	0.9	
High education	100 (90.9%)	97	88.2	3	2.7	
Mother's education[a]						0.078
Low education	14 (12.7%)	12	10.9	2	1.8	
High education	96 (87.3%)	94	85.5	2	1.8	
Family income[b]						0.140
Low	4 (3.6%)	3	2.7	1	0.9	
High	106 (96.4%)	103	93.6	3	2.7	

[a] Parent's education based on minimum education of government's standard (low < senior high school; high = college/university graduates).
[b] Family income based on a minimum salary of Sulawesi Selatan Province (low < 2,400,000; high > 2,400,000).
[c] HbA1c level (normal < 5.7%; prediabetic 5.7–6.4%).
[d] Probability using the chi-square test.

Table 2 Factors related to HbA1c level.

Variable	Mean	Std. deviation	*p*[c]
HbA1c level[a]	5.23	0.27	0.138
Children's age	9.29	1.38	
HbA1c level	5.23	0.27	0.860
Children's weight	41.87	10.49	
HbA1c level	5.23	0.27	0.703
Children's height	135.38	12.74	
HbA1c level	5.23	0.27	0.972
Children's BAZ[b]	2.20	0.84	
HbA1c level	5.23	0.27	0.451
PAQ-C score	33.48	15.87	
HbA1c level	5.23	0.27	0.738
Knowledge score	8.51	2.13	

[a] HbA1c level (normal < 5.7%; prediabetic 5.7–6.4%).
[b] BAZ, BMI for age z score (overweight > +1SD; obesity > +2SD).
[c] Probability using pearson correlation test.

is 135.38 cm, children's BMI z-score is 2.20, PAQ C score is 33.48, and knowledge score is 8.51.

Table 3 shows children who have a family culture that is less supportive as many as 80 children (72.2%) and who support as many as 30 children (27.3%). Prediabetic children with high activity are more (2.7%) than children with low activity (0.9%). All prediabetic children exercise only once a week. There were three children (2.7%) including exercising less than 60 min and one child (0.9%) exercising more than 60 min. Prediabetic children who often snack as many as three children (2.7%) and do not snack as much as one child (0.9%). The habit of consuming fast food more than twice a week was 69 children (62.7%) but still in the normal HbA1c category, while children with prediabetes who consumed fast food more than twice a week were one child (0.9%).

Table 3 Culture and lifestyle children of obesity and overweight in normal and prediabetes HbA1c level (n = 110).

Variable	*n*	HbA1c Level[a]				*p*[b]
		Normal		Prediabetic		
		n	%	*n*	%	
Nutritional status[c]						0.322
Overweight	49 (44.5%)	46	41.8	3	2.7	
Obesity	61 (55.5%)	60	54.5	1	0.9	
Culture						0.299
Less supportive	80 (72.2%)	78	70.9	2	1.8	
Supportive	30 (27.3%)	28	25.5	2	1.8	
Activity						0.537
Low	19 (17.3%)	18	16.4	1	0.9	
High	91 (82.7%)	88	80	3	2.7	
Sport in a week						1.000
3 times a week	19 (17.3%)	19	17.3	0	0	
1 time a week	91 (82.7%)	87	79.1	4	3.6	
Duration of sports						1.000
<60 min	75 (68.2%)	72	65.5	3	2.7	
≥60 min	35 (31.8%)	34	30.9	1	0.9	
Duration of watching TV						0.528
<2 h	88 (80%)	84	76.4	4	3.6	
≥2 h	22 (20%)	22	20	0	0	
Eating frequency						0.586
≤2 times	34 (30.9%)	32	29.1	2	1.8	
≥2 times	76 (69.1%)	74	67.3	2	1.8	
Breakfast						1.000
Yes	47 (42.7%)	45	40.9	2	1.8	
No	63 (57.3%)	61	55.5	2	1.8	
Drink of milk						1.000
Yes	52 (47.3%)	50	45.5	2	1.8	
No	58 (52.7%)	56	50.9	2	1.8	
Snacking						1.000
Yes	71 (64.5%)	68	61.8	3	2.7	
No	39 (35.5%)	38	34.5	1	0.9	
Frequency of soft drink						0.578
<2 times	87 (79.1%)	83	75.5	4	3.6	
>2times	23 (20.9%)	23	20.9	0	0	
Frequency of fast food consumption						0.145
≤2 weeks	41 (37.3%)	38	34.5	3	2.7	
>2 weeks	69 (62.7%)	68	61.8	1	0.9	

[a] HbA1c level (normal < 5.7%; prediabetic 5.7–6.4%).
[b] Probability using chi-square test.
[c] Nutritional status based on BAZ, BMI for age Z score (overweight > +1SD; obesity > +2SD).

Discussion

The study found that the tendency of HbA1c to increase in overweight and obese children with an average value was at an HbA1c level of 5.23% and more in overweight children than obese children. Another study revealed that the value of HbA1c in children at risk of developing diabetes was 5.7–6.4%.[22] The importance of HbA1c examination is an excellent predictor in identifying the risk of diabetes in children and can be used to identify prediabetes in children with type 2 diabetes.[18] This study has illustrated that many HbA1c levels in overweight and obese children of school age have approached the prediabetes threshold, and it is proven that there are children who have prediabetes.

Socio-demographic, family cultural, lifestyle roles are factors that can increase the incidence of prediabetes in overweight and obese children of school age.[3,6,19]

Socio-demography has a role in the incidence of overweight and obese children. This study shows that the trend occurs in the HbA1c level, which is getting closer to the prediabetes threshold, namely the category 5.1–5.4% of which is high family income. In line with other studies that found that education and high parents' income play an important role in increasing HbA1c levels.[23] Other studies have shown an increase in the incidence of obesity in children in China who have high economic status due to the high public purchasing power of obesogenic foods.[24] This is relevant to other studies which reveal that traditional socio-culture and beliefs are related to nutrition, and are mostly passed down for centuries by mothers and grandmothers living in developing countries.[25] This belief includes overweight and obese children often said to have baby fat that parents believe will disappear when they get older. Also, the culture of the Bugis-Makassar tribe is typical of sweet foods that are always served on certain occasions, by families usually prepared as a routine meal for their children at home which is a risk factor for the incidence of prediabetes.

Based on gender, overweight and obese men have a higher school age than girls. The results of this study are in line with other studies conducted in Shenzhen, China, which found that the prevalence of prediabetes was 13.01% for men and 11.15% for women.[26] Girls have a higher percentage of total body fat during puberty, while boys have more central obesity, which is a risk factor for insulin resistance and type II diabetes.[27]

In this study, children who have prediabetes have more activity than low activity because there are other factors that can cause children to experience prediabetes, such as exercise that is only twice a week, the duration of exercise is also less than 60 min, frequency of eating more than two times, high snacking habits, and frequency of fast food consumption more than twice a week. Other studies show that children who snack more than one day per week have higher HbA1c levels compared to children who are not snacking or who are less than one day per week.[28] Most high-income families tend to choose their food, especially fast food, and high carbohydrate so that people experience excess food intake and obesity or being overweight will be difficult to avoid.[29]

However, this study has limitations. This study did not have an underweight and normal weight participant to be compared with overweight children. Therefore, further research is needed on screening HbA1c in all school-age children based on nutritional status and assessing the food intake. However, this data provides significant findings, including the high level of HbA1c levels that occur among overweight and obese children, and its relationship with the socio-demographic and lifestyle characteristics of children.

Conclusion

The study found that overweight and obese children had prediabetes, and more than half of overweight and obese children had HbA1c level at the borderline of being prediabetes. Socio-demographic, family cultural, and lifestyle play a role in increasing the risk of prediabetes in school-aged overweight and obese children.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgments

The author thanked the children and parents who participated in this study. To all data collectors and the Institute of Research and Community Service (LPPM) of Universitas Hasanuddin. We also thank the government (KEMENRISTEKDIKTI) for supporting this research.

References

1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014;384:766–81, http://dx.doi.org/10.1016/S0140-6736(14)60460-8.
2. Ogden CL, Carroll MD, Fryar CD, Flegal KM. Prevalence of obesity among adults and youth: United States, 2011–2014. United States; 2015.
3. Syahrul S, Kimura R, Tsuda A, Susanto T, Saito R, Ahmad F. Prevalence of underweight and overweight among school-aged children and it's association with children's sociodemographic and lifestyle in Indonesia. Int J Nurs Sci. 2016;3:169–77, http://dx.doi.org/10.1016/j.ijnss.2016.04.004.
4. Gupta N, Goel K, Shah P, Misra A. Childhood obesity in developing countries: epidemiology, determinants, and prevention. Endocr Rev. 2012;33:48–70, http://dx.doi.org/10.1210/er.2010-0028.
5. Badan Penelitian dan Pengembangan Kesehatan Kementerian Kesehatan R. Riset Kesehatan Dasar Riskesdas; 2013.
6. Susanto T, Syahrul, Sulistyorini L, Rondhianto, Yudisianto A. Local-food-based complementary feeding for the nutritional status of children ages 6–36 months in rural areas of Indonesia. Korean J Pediatr. 2017;60:320–6, http://dx.doi.org/10.3345/kjp.2017.60.10.320.
7. BPS. Jumlah kasus 10 penyakit terbanyak di Kabupaten Garut; 2016.
8. Erika K, Nurachmah E, Rustina Y, As'ad S, Nontji W. Effect of family empowerment modified model to a family's ability in controlling life style and physical activity of children with overweight and obesity. Pakistan J Nutr. 2016;15:737–44.
9. Levesque RJR. Obesity and overweight. Encycl Adolesc. 2018:2561–5, http://dx.doi.org/10.1007/978-3-319-8-4_4473322.
10. Sjattar EL, Syahrul, Bulkis AS, Syam Y, Tahir T. Effect of vitamin C supplementation on inflammation marker in obese children: a quasi-experimental study. Pakistan J Nutr. 2017;16:187–92, http://dx.doi.org/10.3923/pjn.187.1922017.
11. CDC. Childhood Obesity Causes & Consequences. 2012. Available from: https://www.cdc.gov/obesity/childhood/causes.html.
12. Budianto. Dasar-Dasar Ilmu Gizi. Malang: UMM Press; 2009.
13. Morandi A, Maschio M, Marigliano M, Miraglia Del Giudice E, Moro B, Peverelli P, et al. Screening for impaired glucose tolerance in obese children and adolescents: a validation and implementation study. Pediatr Obes. 2014;9:17–25, http://dx.doi.org/10.1111/j.2047-6310.2012.00136.x.

14. McConnell EA. Pathophysiology: clinical concepts of disease processes. AORN J. 2007;37:876–7, http://dx.doi.org/10.1016/s0001-2092(07)70020-0.
15. Erika KA, Patellongi I, Taiyeb AM. Peranan lifestyle terhadap kejadian pra-diabetes di kota makassar [The role of lifestyle in the incidence of pre-diabetic at the city of Makassar]. Bionature. 2010;11:100–6.
16. Sherwani SI, Khan HA, Ekhzaimy A, Masood A, Sakharkar MK. Significance of HbA1c test in diagnosis and prognosis of diabetic patients. Biomark Insights. 2016;11:95–104, http://dx.doi.org/10.4137/Bmi.s38440.
17. Incani M, Sentinelli F, Perra L, Pani MG, Porcu M, Lenzi A, et al. Glycated hemoglobin for the diagnosis of diabetes and prediabetes: diagnostic impact on obese and lean subjects, and phenotypic characterization. J Diabetes Investig. 2015;6:44–50, http://dx.doi.org/10.1111/jdi.12241.
18. Vijayakumar P, Nelson RG, Hanson RL, Knowler WC, Sinha M. HbA1c and the prediction of type 2 diabetes in children and adults. Diabetes Care. 2017;40:16–21, http://dx.doi.org/10.2337/dc16-1358.
19. Syahrul S, Kimura R, Tsuda A, Susanto T, Saito R, Agrina A. Parental perception of the children's weight status in Indonesia. Nurs Midwifery Stud. 2016. doi:10.17795/nmsjournal38139. [in press].
20. World Health Organization. WHO child growth standard BMI-for-age (5–19 years). WHO.
21. Kowalski KC, Crocker PRE, Donen RM. The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual. Saskatoon: University of Saskatchewan; 2004.
22. Wijaya A, Aditiawati A, Saleh I. Akurasi Pemeriksaan HbA1c dalam Mendeteksi Gangguan Toleransi Glukosa pada Anak dan Remaja Obes dengan Riwayat Orang Tua DM Tipe 2. Sari Pediatr. 2016;17:17, http://dx.doi.org/10.14238/sp17.1.2015.17-20.
23. Gesuita R, Skrami E, Bonfanti R, Cipriano P, Ferrito L, Frongia P, et al. The role of socio-economic and clinical factors on HbA1c in children and adolescents with type 1 diabetes: an Italian multicentre survey. Pediatr Diabetes. 2017;18:241–8, http://dx.doi.org/10.1111/pedi.12378.
24. He W, James SA, Giovanna Merli M, Zheng H. An increasing socioeconomic gap in childhood overweight and obesity in China. Am J Public Health. 2014;104:14–22, http://dx.doi.org/10.2105/AJPH.2013.301669.
25. Hassapidou MN, Papadopoulou SK, Frossinis A, Kaklamanos I, Tzotzas T. Sociodemographic, ethnic and dietary factors associated with childhood obesity in Thessaloniki, Northern Greece. Hormones. 2009;8:53–9, http://dx.doi.org/10.14310/horm.2002.1222.
26. Yang C, Ding Z, Zhou H, Chen D, Huang Z, Yang C, et al. Prevalence of prediabetes by the fasting plasma glucose and HbA1c screening criteria among the children and adolescents of Shenzhen China. J Diabetes. 2018, http://dx.doi.org/10.1111/1753-0407.12820.
27. Wang G, Arguelles L, Liu R, Zhang S, Brickman WJ, Hong X, et al. Tracking blood glucose and predicting prediabetes in chinese children and adolescents: a prospective twin study. PLoS ONE. 2011;6:e28573, http://dx.doi.org/10.1371/journal.pone.0028573.
28. Jansen H, Wijga AH, Scholtens S, Koppelman GH, Postma DS, Brunekreef B, et al. Change in HbA1c levels between the age of 8 years and the age of 12 years in Dutch children without diabetes: the PIAMA birth cohort study. PLOS ONE. 2015;10:1–11, http://dx.doi.org/10.1371/journal.pone.0119615.
29. Freitag H. Bebas Obesitas Tanpa Diet Menyiksa. Yogyakarta: Media Pressindo; 2010.