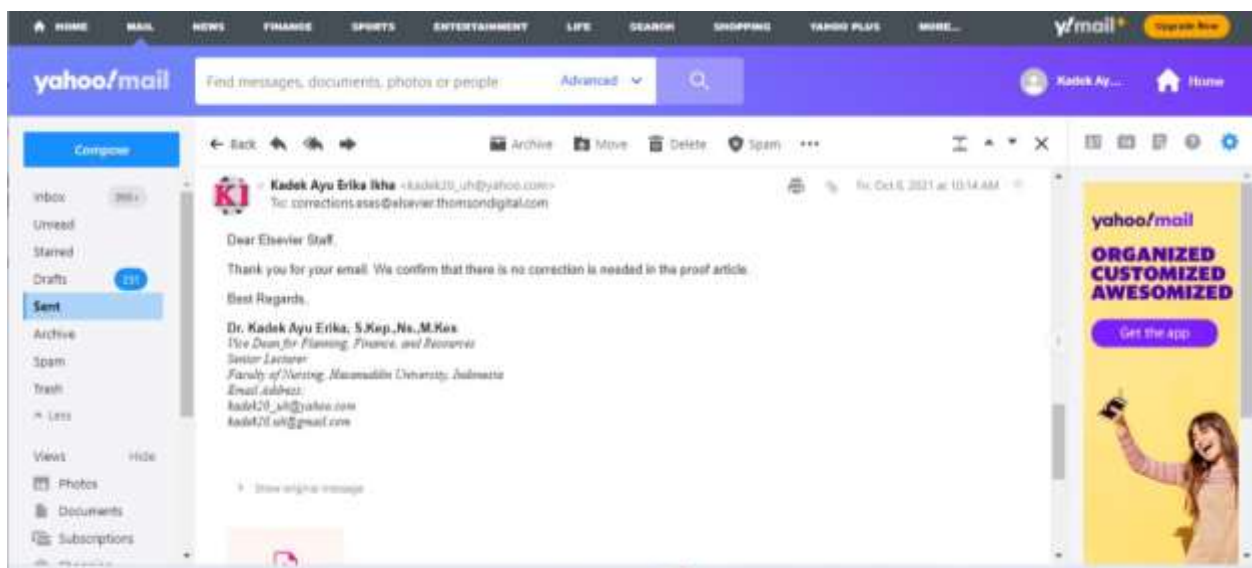
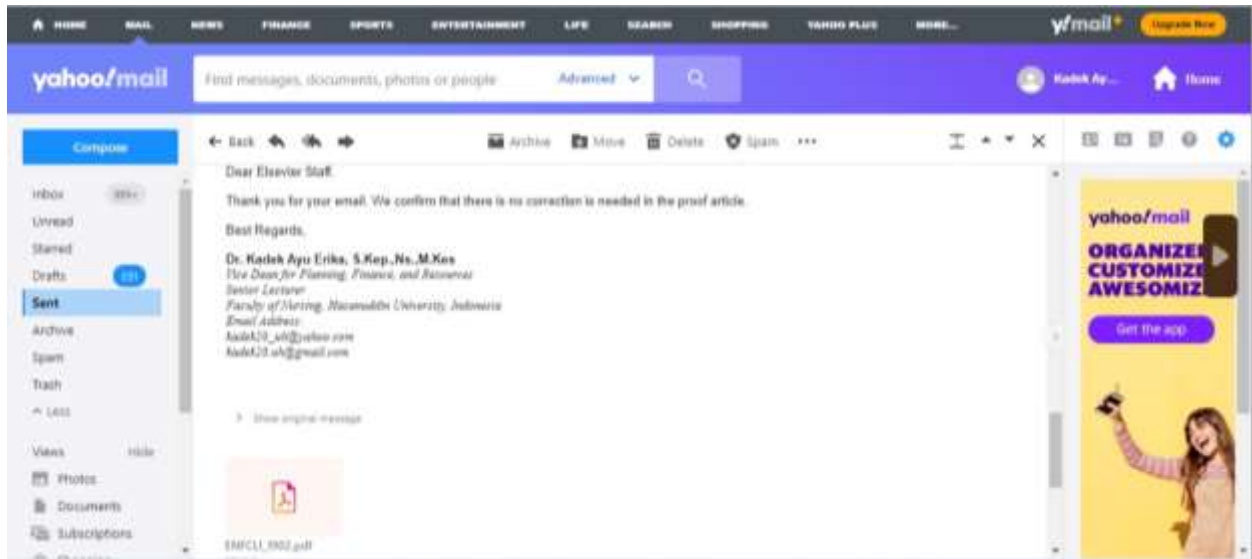


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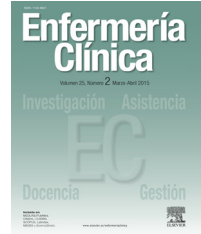
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## Prediabetes among overweight and obese school-aged children: A cross-sectional study

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### KEYWORDS

Prediabetes;  
Lifestyle;  
HbA1c level;  
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Overweight;  
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### 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  $\geq$  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.

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### 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

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has experienced an increase.<sup>1</sup> In 2014 it was estimated that 41 million children under five years were obese. In the 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.<sup>2</sup> In Indonesia, obesity also has high prevalence.<sup>3</sup> 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.<sup>4</sup> 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.<sup>5,6</sup>

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.<sup>3,8</sup> Increased of overweight occurs more in children of school age who are in urban areas.<sup>5</sup> Obesity in childhood can increase the risk of early death and disability in adulthood.<sup>9</sup> 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.<sup>10,11</sup> Obesity is influenced by several factors such as poor diet, physical activity, limited sleep, genetic factors, even illness or drugs.<sup>11</sup> 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.<sup>12</sup>

Obese children diagnosed with TGT are prediabetic stadiums that should undergo a prevention program with lifestyle improvements and healthy bodyweight.<sup>13</sup> 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.<sup>14</sup> Lifestyle has been shown to play a role in the incidence of prediabetes through obesity.<sup>15</sup> Hemoglobin A1c (HbA1c) is recommended as a diagnostic tool for identifying DM and subjects at risk of developing Diabetes Mellitus (DM),<sup>16,17</sup> and HbA1c is a perfect predictor in identifying diabetes risk in children and can be used to identify prediabetes in children.<sup>18</sup>

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.<sup>19</sup> 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

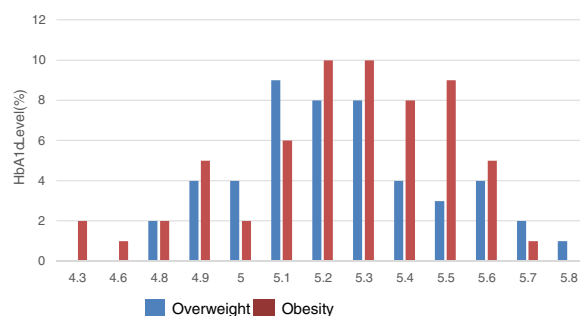


Figure 1 HbA1c level among overweight and obese children (n = 110).

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.<sup>20</sup> 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).<sup>21</sup>

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

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

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

<sup>a</sup> Parent’s education based on minimum education of government’s standard (low < senior high school; high = college/university graduates).

<sup>b</sup> Family income based on a minimum salary of Sulawesi Selatan Province (low < 2,400,000; high > 2,400,000).

<sup>c</sup> HbA1c level (normal < 5.7%; prediabetic 5.7–6.4%).

<sup>d</sup> Probability using the chi-square test.

**Table 2** Factors related to HbA1c level.

Variable	Mean	Std. deviation	p <sup>c</sup>
HbA1c level <sup>a</sup>	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 <sup>b</sup>	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	

<sup>a</sup> HbA1c level (normal < 5.7%; prediabetic 5.7–6.4%).

<sup>b</sup> BAZ, BMI for age z score (overweight > +1SD; obesity > +2SD).

<sup>c</sup> Probability using pearson correlation test.

134 child is 9.29 years old, bodyweight is 41.87 kg, body height  
135 is 135.38 cm, children’s BMI z-score is 2.20, PAQ C score is  
136 33.48, and knowledge score is 8.51.

137 **Table 3** shows children who have a family culture that  
138 is less supportive as many as 80 children (72.2%) and who  
139 support as many as 30 children (27.3%). Prediabetic chil-  
140 dren with high activity are more (2.7%) than children with

141 low activity (0.9%). All prediabetic children exercise only  
142 once a week. There were three children (2.7%) including  
143 exercising less than 60 min and one child (0.9%) exercising  
144 more than 60 min. Prediabetic children who often snack as  
145 many as three children (2.7%) and do not snack as much  
146 as one child (0.9%). The habit of consuming fast food more  
147 than twice a week was 69 children (62.7%) but still in the



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

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

<sup>a</sup> HbA1c level (normal < 5.7%; prediabetic 5.7–6.4%).

<sup>b</sup> Probability using chi-square test.

<sup>c</sup> Nutritional status based on BAZ, BMI for age Z score (overweight > +1SD; obesity > +2SD).

148 normal HbA1c category, while children with prediabetes who  
149 consumed fast food more than twice a week were one child  
150 (0.9%).

## 151 Discussion

152 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%.<sup>22</sup> 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.<sup>18</sup> This study has illustrated that many  
HbA1c levels in overweight and obese children of school

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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.<sup>3,6,19</sup>

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.<sup>23</sup> 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.<sup>24</sup> 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.<sup>25</sup> 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.<sup>26</sup> 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.<sup>27</sup>

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.<sup>28</sup> 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.<sup>29</sup>

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 interests

The authors declare no conflict of interest.

## Uncited reference



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