

Snacking Energy-dense Food Related to Childhood Obesity

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Abstract

Purpose: Aims to observe the relation of the pattern of energy-dense food consumption, snacking, and access to food with the obesity in children aged 9-12 years.

Design/methodology/approach: A cross sectional study done in elementary school in Surabaya, Indonesia involving 110 students. Pattern of energy-dense food consumption was retrieved from FFQ and energy from snacking was collected through repeated 24 hours food recall. Linear regression analysis was performed with $\alpha = 0.05$.

Findings: Obesity prevalence was 50.0% and obese children proved to have higher energy intake compared to non-obese children ($2131.7 \text{ kcal} \pm 405.758 \text{ SD}$ vs. $1753.4 \text{ kcal} \pm 452.673 \text{ SD}$, respectively). Energy-dense food consumption pattern that related to obesity was consumption of chocolate ($p=0.028$; $R^2=0.044$); white sugar ($p=0.017$; $R^2=0.051$); snack bar ($p=0.014$; $R^2=0.055$); fried foods ($p=0.001$; $R^2=0.096$); sweetened condensed milk ($p=0.022$; $R^2=0.048$); fruit syrup ($p=0.008$; $R^2=0.063$); and biscuits ($p=0.029$; $R^2=0.044$). Highest frequency of energy-dense food intake was flavoured drinks with intake as much as 27 times per month ($p=0.051$). Energy intake from snacking also found to be higher in obese children ($698.6 \text{ kcal} \pm 275180 \text{ SD}$) compared to non-obese children ($494.9 \text{ kcal} \pm 280.952 \text{ SD}$).

Research limitations/implications: An observational study hence causation between variables cannot be justified.

Practical implications: The result can be referred as an input for the inclusion and exclusion of foods permitted at school-setting in order to prevent childhood obesity.

Originality/value: The result adds more evidence related to school food environment in urban developing country setting which are under studied.

Keywords: Childhood obesity; Energy-dense food; Local snack; Snacking; Sugar

Nomenclature

Definitions, Acronyms and Abbreviations:

IOS: iPhone Operating System; IPAQ: The International Physical Activity Questionnaire; KEPK: Komite Etik Penelitian Kesehatan (Health Research Ethic Committee); RISKESDAS: Riset Kesehatan Dasar (Basic Health Research)

Introduction

A nutrition transition lead to several consequences related to nutrition and health, which one of it is childhood obesity. Globally, by 2013, the number of children under five who are overweight is estimated at more than 42 million, while 31 million of them live in developing countries [1]. Obesity that occurs in children in the long period is at risk of obesity in adulthood which later will be at risk of non-communicable diseases disease such as type 2 diabetes, hypertension, lung and heart problems [2,3]. In Indonesia, the data of Basic Health Research (Riskesdas) in 2013 shows that the problem of obesity in children aged 5-12 years in Indonesia is still high at 18.8%, consisting of 10.8% overweight children and 8.0% are obese children (Indonesia MoH, 2013). East Java is one of the 15 provinces in Indonesia with the highest number of obesities, even more exceeded national prevalence (19.3%).

The problem of child obesity worldwide mostly occurs in low- or middle-income families, especially in urban areas [4]. Previous research conducted in Ploso II No. 173 elementary school, Surabaya showed that the prevalence of overweight and obesity in primary school children is 20%, consisting of 18% overweight and 2% obesity [5]. In addition,

study of Rosyidah [6] at Ploso I-172 elementary school Surabaya also showed that the prevalence of overweight and obesity in school children was 28.8% and 34.6%, respectively. In general, obesity is triggered by positive energy balance, where energy intake is higher than energy out then resulted in fat accumulation in the body. Moreover, factors that could affect the incidence of obesity in school children are due to home, school, and social environment factor [5]. Obesity occurring in school children at Ploso I-172 elementary school, Surabaya is caused by wrong eating pattern, in which children are preferring to eat high fat food and high sugar [7]. In addition, excess energy intake and fat accompanied by mild activity also affect the incidence of obesity [6]. A study in other city in Indonesia (Manado) also found that energy consumption higher than Indonesian RDI due to wrong eating pattern were positively correlated with child obesity [8].

The availability and access of food at home will affect the intake of child feeding. The food provided at home will determine what foods will be eaten by the child [9]. Research conducted by Luszczynska et al. found that consumption of light snacks and sugary drinks was reduced if parents

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did not provide them at home. If parents provide vegetables, fruits and juices at home, then the consumption of children's vegetables and fruits also increases. This study is comparable to Wang et al., [10] that indicating a link between the availability of food at home and the intake of child feeding. The availability of chips and sweets at home causes the intake of sweet and mild foods in children increases which results in overweight and obesity in children. Other consumption patterns that affect the occurrence of overweight and obesity is the pattern of high fat, high calorie, and high sugar consumption or so-called energy-dense food. Based on research conducted on children, adolescents, and adults in Japan shows that energy-dense, high-sugar, and high-fat foods are at risk for overweight and obesity (p -value = 0.048) [11]. Consumption of foods with high energy density can excessively lead to excessive intake of food that will lead to the occurrence of overweight and obesity [12]. BMI for age is a common indicator for measuring growth patterns in children and adolescents and also an indicator to determine overweight and obesity among children.

The intake of high energy-dense food and snacking pattern is not widely observed in related to childhood obesity. In the other hand, children are accustomed to eat snacks and high energy-dense food especially in school where parents have no control over it. Therefore, the study was conducted to further investigate on energy-dense food consumption, snacking and access to food in relation with obesity in children aged 9-12 years old.

Methods

Study design and sampling

This cross-sectional study was conducted in Ploso I-172 elementary school in Surabaya, Indonesia based on previous study that found obese prevalence among children reached 34.6% [6]. The population study was children aged 9-12 years registered in the elementary school with total number of 322 students. The minimum sample required for this study was 55 children based on the formula for estimation of a population proportion advised by Lemeshow [13]. Out of 322 students, we recruited 110 subjects to anticipate drop out or incomplete data. Subjects were recruited based on inclusion criteria which are:

- Registered in class IV, V, and VI,
- Allowed by the guardian to comply the study,
- Have no special diseases that need diet modification (i.e. type 1 diabetes, kidney damage, etc.); while the drop out criteria is children got sick and could attend the day of data collection.

Measures

Data were collected using a structured questionnaire in Indonesian language by trained enumerators on demography and household food expenditure. Interview was done at school without disturbing school hours. Data of energy-dense food intake was collected using a Food Frequency Questionnaire (FFQ) and also interviewed by trained enumerators (nutrition students), while data of snacking was collected using 2 days 24 hours' food recall in non-consecutive day to portrait the individual intake. List of popular snacks consumed among children was obtained from observation in several schools in Surabaya and through food recalls. The FFQ to assess energy-dense food intake was previously validated before the study conducted. Lastly, obesity was measured directly with anthropometric measurement. Weight measurement was done using digital scale with precision 0.1 kg and height was measured using microtoice with precision 0.1 cm. This research was approved by the Institutional Review Board (IRB) at the

Faculty of Public Health, Universitas Airlangga on May 2, 2017 with reference or proposal number: 174-KEPK. We made sure that potential participants were not pressured to participate and none of their right would be obliterated if unwilling to participate, furthermore, the confidentiality was preserved. Informed consent was obtained prior to data collection. Participants were free to withdraw from the study at any time without negative consequences.

Data analysis

The category of childhood obesity was calculated from anthropometric data. Body mass index was first calculated by divided weight (in kg) to height (in meter square) then compared to WHO Growth Chart. Data retrieved from FFQ was presented in intake per month, calculated by structured formula in Microsoft Excel and data from 2 days 24 hours food recall was imputed in NutriSurvey software with Indonesian Food Database to produce data of snacking intake. Data of snacking then presented in quintiles of intake. Similar to snacking intake, data of access to food which calculated from household food expenditure was also presented in quintiles. Data entry and statistical analysis were done using SPSS program for Windows 16. Data presented including mean/medium and standard deviation values for numeric data and percentage for categorical data. Bivariate analysis was also performed using linear regression test to determine the relationship between independent and dependent variables in $\alpha = 0.05$.

Results

Most of the respondents were girls (51%) and mean age of subjects was 10.37 ± 0.866 SD with majority of subjects were in age of 10 years old. Based on parent's characteristic, it is found that third quarters were already having higher education or more than nine year of schooling. Furthermore, more than a half of mothers were not working and mostly spent their time at home. Parent income at most 29.1% was at 1st quintile 1 (600,000-2,000,000), the rest 24.5% at third quintile (2,781,200-3,500,000) and 22.7% at 4th quintile 4 (3,550,000-6,000,000). Half of the parent's income were already above the regional minimum wage. The study also revealed that half of the students were obese based on BMI-for-age indicator. Further analysis found the prevalence of obesity was slightly higher in girls (26.4%) than boys (23.76%).

The average energy intake in the normal nutritional status group was $1753.4 \text{ kcal} \pm 452.673$ SD, while the average energy intake in the obese group was $2131.7 \text{ kcal} \pm 405.758$ SD. It is also found that carbohydrate, protein, and fat intake were all higher in obese children (309.9 g vs. 266.4 g; 61.3 vs. 52.2 g; 63.4 g vs. 51.2 gr, respectively for obese and non-obese children). Compared to the Indonesian Recommended Dietary Intake (RDI), only 17.0% of subjects have an intake more than 120% of RDI. The data of energy intake then further analyse for its contribution for snacks.

The pattern of energy-dense food consumption was categorized into 3 categories, including: daily, weekly, and monthly. The distribution of the frequency of energy-dense food in school children can be seen in Figure 1.

The results of the study in Figure 1 shows that the most consumed energy-dense foods in daily frequency was flavoured drinks (minuman berperisa) (50.0%). Almost all snacks showed the same amount of intake at weekly frequencies, but a few snacks were more consumed on the monthly frequency, including popcorn, soft drinks, isotonic drinks and ice shake (es kocok). The next Figure 2 showed the comparison of energy-dense food consumed by obese and non-obese children in daily

basis. It is known that most daily energy-dense food were consumed by obese children groups.

Those energy-dense food including biscuits, wet cakes, pudding, pastels, fruit syrups, chocolate flavoured drinks, isotonic drinks, fruit juices, flavoured drinks, soft drinks, ice shakes, chocolate, candy, papeda, sweetened condensed milk, milkshakes, ice cream, milk, fried foods, otak-otak and sausages, cireng and cilok, pentol, chips, crackers, snack bar, fried nuts, popcorn, white sugar, sauce and toppings.

Figure 3 shown the result of linear regression analysis. The result indicates that median value on energy-dense food pattern of biscuit is 8, and result of statistical test of $p=0.029$ which means that there was a correlation between the pattern of biscuit consumption with obesity (BMI/age) with R^2 value 0.044.

Those implies that biscuit consumption patterns contribute 4.4% in affecting obesity in children, and the rest is influenced by other variables. The next is fruit syrup consumption in which consumption pattern was 10 times per month. The result of analysis found $p=0.008$ means that there is relation of consumption pattern of fruit syrup with obesity (BMI/age). The calculation also obtained $R^2=0.063$, which

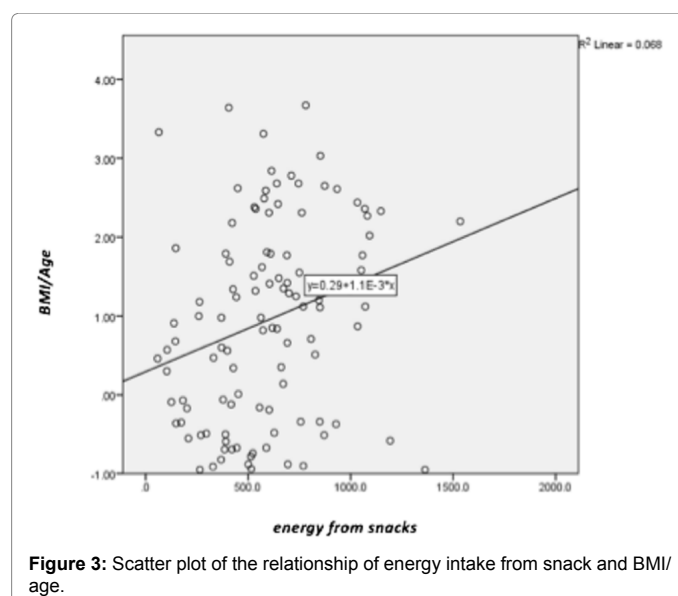


Figure 3: Scatter plot of the relationship of energy intake from snack and BMI/ age.

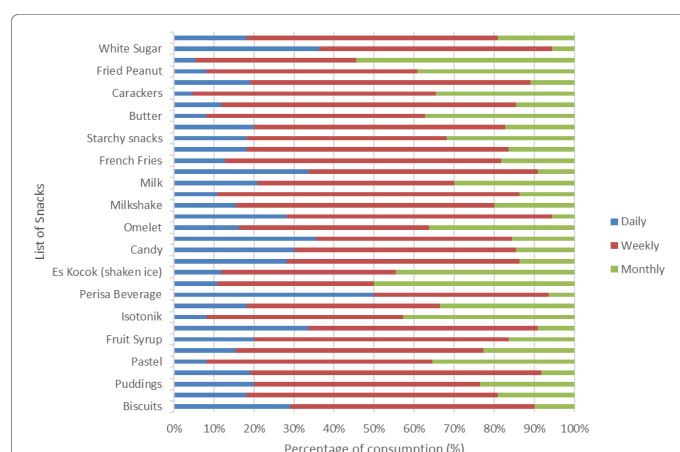


Figure 1: The distribution of the frequency of energy-dense food in school children.

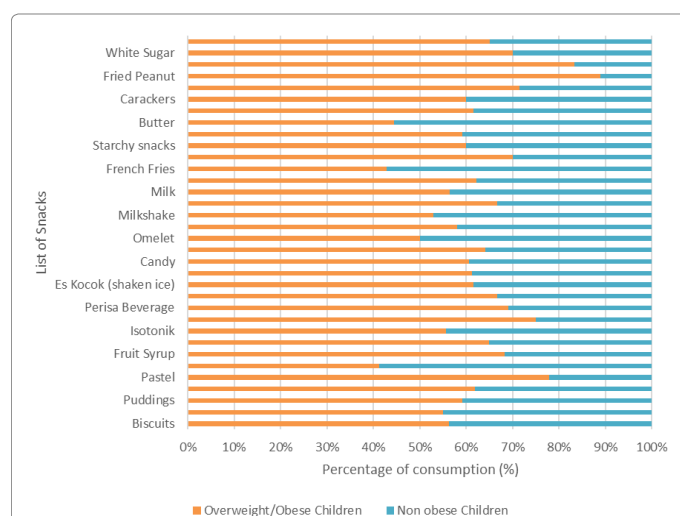


Figure 2: The comparison of energy-dense food consumed by obese and non-obese children.

implies that the consumption pattern of fruit syrup contributes 6.3% in affecting obesity, and the rest is influenced by other variables. Other energy-dense food consumption pattern that related to obesity (BMI/age) was the consumption of chocolate flavour snacks ($p=0.028$; $R^2=0.044$); sweetened condensed milk ($p=0.022$; $R^2=0.048$); fried snacks ($p=0.001$; $R^2=0.096$); otak-otak and sausages ($p=0.006$; $R^2=0.067$); snack bar ($p=0.014$; $R^2=0.055$); and white sugar ($p=0.017$; $R^2=0.051$). The consumption pattern of other energy-dense foods was not associated to obesity (Figure 3).

The average energy intake from daily snacks of school children was $596.7 \text{ kcal} \pm 295.102 \text{ SD}$. The results of analysis using linear regression test between energy intake from snack with BMI/age resulted $p=0.006$, meaning that there was relation of energy intake from snack with BMI/age. The scatter plot (Figure 3) shows that the relationship between energy intake from snacks with obese was linear or positive correlation, which means that the higher energy intake of snacks per day, the higher the BMI/age of the children and the closer the BMI/age of obese.

The value of R^2 was 0.068 implies that the influence of intake of energy intake from snacks per day to BMI/age was 6.8%. Average household food expenditure was $\text{IDR } 2,135,809 \pm 945,910.546 \text{ SD}$. Linear regression analysis revealed $p=0.563$ which means there was no relationship of household food expenditure with obesity (BMI/age) in children. Based on the scatter plot can also be seen that the plot is spreading and shows that the relationship was not linear.

Discussion

In general, consumption of energy-dense food among subjects was quite high, considered the average intake per month is vary from 1-27 times per month in which highest energy-dense food consumption patter was found in flavoured drinks. The results also showed most of the energy-dense food intake in daily frequencies consumed by the obese group. The consumption patterns of energy-dense foods were found to be significantly related to obesity based on BMI/age. Energy-dense food meant in this study was food and beverages that have higher content of energy, sugar, and fat. This result was consistent with studies conducted on children, adolescents, and adults in Japan, which exhibit that energy-rich, high-sugar, and high-fat foods were at risk of overweight and obesity ($p\text{-value}=0.048$) [11]. Consumption of foods

with high energy density excessively lead to excessive intake of food that will affect the incidence of overweight and obesity [12]. Foods with high energy density usually contain low protein. In addition, foods with high energy density have high saturated fat or trans-fat. Although sugar is not included in foods with energy density, sugar is also a critical determinant of weight change that has significant relationship with weight gain [14], therefore it is included as one of obesity risk factor.

The consumption pattern of energy-dense food such as fried foods, otak-otak and sausages were also affect obesity (BMI/age). Fried snacks, otak-otak and sausages were included as fast food. was in line with research conducted by Oktafiandi [15] who stated that children with fast food consumption patterns were having 5.133 times greater risk to experience obesity incidences than children with rare fast food consumption patterns. Fast food consumption most often consumed by schoolchildren is sausage and otak-otak. The occurrence of overweight and obesity in children was due to the portions size of fast food than eaten excessively. Large portion sizes lead to weight gain [16]. Other than that, consumption pattern of biscuits, fruit syrups, chocolate, sweetened condensed milk, snack bars, and white sugar were also correlate to obesity (BMI/age). Those findings were in accordance with Grimes et al. [17] study indicating that there was a strong relationship between increased consumption of Sugar-Sweetened Beverages (SSBs) with overweight/obesity. Sugar-Sweetened Beverages (SSBs) are referred as fruit syrup, chocolate, and white sugar [18]. Each 1% increase in SSBs consumption will increase 4.8 overweight cases per 100 people, and 2.3 cases of obesity per 100 people, especially in low-and middle-income countries. Another study showed that children who consumed ≥ 1 SSBs per day would increase their Body Mass Index (BMI) higher than children who did not consume SSBs. Children who consumed ≥ 1 times SSBs daily were having 1.55 times risk of overweight / obesity than children who did not consume SSBs [19]. The consumption of SSBs can also cause children to reduce their intake nutritious foods and drinks, and it will impact on the deficiencies of some important nutrients such as calcium, iron, folate and vitamin A. In addition, increased consumption of SSBs may also increase the risk of dental caries [20]. Several ways to reduce the consumption of SSBs among children by replacing the SSBs drinks with water drinks, fruit juices, and milk can reduce excessive calorie intake, and reduce the risk of overweight / obesity [21].

The increasing frequency of snacking will also increase the daily energy intake [22]. This statement is supported by the results of this study which shows that energy intake in the obese group with higher daily frequency (2131.7 kcal) than the energy of non-obese group (1753.4 kcal). Bo et al., [23] indicate that adolescents with higher frequency and portion of energy-dense food intake showed higher energy intake as well. In this study, children consume energy-dense food at least once per day. The average energy intake from snack in obese children (698.6 kcal) was more than average of energy intake from snack from in non-obese children (494.9 kcal). The results of this study were in accordance with Aninditya [24] study, which shows that the average of energy intake and macronutrients from snacks in the school environment is higher in obese children compared with normal children. In average, obese children consumed 2131.7 kcal per day which means that intake from snacks contribute to 32.7% of total energy intake. Aninditya [24] states that the consumption of snacks with energy $\geq 30\%$ of energy intake a day has a 3.24 times higher risk to become obese. Snacks that are often consumed by children were biscuits, wet cakes, pudding, pastel, fruit syrup, chocolate flavoured drinks, isotonic drinks, fruit juices, flavoured drinks, soft drinks, ice shake, chocolate, candy, papeda, sweetened condensed milk,

milkshakes, ice cream, fried food, pentol, chips, syrup, sauce, and toppings. The energy intake of snacks mostly obtained from foods that tend to contain high energy and simple carbohydrates as an energy source. In addition, it was also supported by the fact that students are preferring to eat snacks sell in the school canteen and outside the home rather than eating food from home, rarely breakfast before leaving for school and never bring food from home. This study revealed that local snack consumed by the school children are mainly having high energy density, even though, several local snacks are actually proven to have better nutrition profile or low energy density such as gethuk (cassava cake), onde-onde (boiled rice cake with green beans filling), quail eggs satay, and others. Unfortunately, these local snacks are rarely found in schools due to because few children like it.

Energy intake from snacks was also associated with childhood obesity based on BMI/age. Harvi [25] supported this finding that shows a correlation between the contribution of energy in the aged 13-15 years in Ungaran Barat sub-district ($p=0.003$) with correlation value 0.160 meaning that higher energy intake from snacks, the higher BMI/age z-score. Another study supported is that Pramono and Sulchan [26] indicating that there is a correlation between the contribution of snacks and obesity in adolescents, further explaining that adolescents with energy intake from snack higher than 300 kcal per day will increase the risk of obesity as much as 3.2 times higher. High energy intake from snacks was due to the higher frequency of snacks consumption. On average, children who experience obesity are consume high-sugar snacks in daily frequency (1-4 times a day). Snacks that contributes in high intake of energy in this study are foods high in sugar including biscuits, syrup, chocolate, and sweetened condensed milk. Intake of energy derived from excess fat, carbohydrates, and protein will be stored in the form of fat and glycogen in adipose tissue or called lipogenesis. Lipogenesis is the formation of fat (a change from non-fat food ingredients to body fat). The more energy intake from non-fat, fat deposits in adipose tissue will be expanded and resulting in obesity [27].

However, this study did not find the relation of household food expenditure with obesity. Both non-obese and obese family food expenditure accounted for 63.65% and 62.59%. The higher percent of food expenditure ($>60\%$) means the less prosperous the household is. Conversely, the smaller percent of food expenditure ($<60\%$) means the more prosperous households is [28]. The absence of a link between household food expenditure and nutritional status is more due to the average household food expenditure in the normal nutritional status and obese children were almost similar. The average monthly food expenditure on non-obese was IDR 2,060,360, while the average monthly food expenditure of obese children was IDR 2,211,258. In addition, food expenditure data generated in this study is less varied. Moreover, this study also did not measure other factors related to obesity mainly physical and sedentary activity. Further study should mention these factors as those also contribute to childhood obesity.

Conclusion

In conclusion, the consumption pattern of energy-dense food and snacking were both associated with childhood obesity based on BMI/age, but not for food access. Several energy-dense foods that need to be reduced to lowering obesity risk are flavoured drinks, biscuits, syrup, chocolate, and sweetened condensed milk. Moreover, the prevalence of obesity in the study was found to be higher (50.0%). This study can describe the individual intake of children because the use of 2 days 24 hours food recall. This study successfully illustrates that some local

snacks are proven to have high energy content that could increase the risk of obesity among children. It also gave us knowledge to substitute several contents of snacks such as reducing sugar, artificial flavourings, syrup or sweetened condensed milk to lower the energy content.

Further Work

Intervention on manipulating school food environment which are promoting healthy food options or limiting energy-dense food and snacks.

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