Original Article

Association of energy intake and physical activity with overweight among Indonesian children 6–12 years of age

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Background and Objectives: Indonesia is currently facing double burden malnutrition in children. As overweight and obesity are due to a disturbed energy balance, this study aimed to assess the association of total energy intake and physical activity with the prevalence of overweight among Indonesian children. **Methods and Study Design:** The data used for this analysis were from 1143 children, 6-12 years old, that participated in the South East Asian Nutrition Survey (SEANUTS). Physical activity (PA) was measured using pedometers for 2 consecutive days and was categorized low, moderate and high. Child nutritional status was categorized based on body mass index for age z-scores (BAZ) into normal weight (-2 SD ≤BAZ≤1 SD) or overweight (BAZ >1 SD). Energy intake was calculated from a one day 24 hour recall and compared to the Indonesian recommended dietary allowance (RDA) for energy. **Results:** Children with low PA had higher risk (ODDs 3.4, 95% CI: 2.0, 6.0) of being overweight compared to children who had high PA. Children with moderate PA and energy take >100% RDA had higher risk (ODDs 4.2, 95% CI 1.9, 9.3) of being overweight than children with high PA and energy intakes ≤100% RDA. **Conclusions:** Low physical activity independently or moderate physical activity and high energy intake are risk factors for Indonesian children to get overweight. Program intervention such as increasing physical activity at school and home is needed to reduce overweight among children.

Key Words: energy intake, Indonesian children, overweight, physical activity, socio-economic status

INTRODUCTION

Indonesia is currently facing the problem of under nutrition and over nutrition in children at the same time. The Basic National Health Survey (*Riskesdas*) 2013 showed that the prevalence of underweight, overweight and obesity in children aged 5–12 years was 11.2%, 10.8% and 8.0% respectively.[1] In 2010 the prevalence of underweight was 12.2% and the prevalence of obesity was 9.2%, thus underweight seems to have decreased while overweight and obesity have slightly increased.[2]

Worldwide the prevalence of childhood overweight and obesity is high and increasing in many countries.[3,4] A decreasing physical activity is probably the main reason for the rise in prevalence of overweight and obesity in industrialised countries.[5] Indonesia as developing country is showing the same problem. Spending more time watching television or playing games with the computer has also become common in Indonesia, especially in children living in urban areas.[6] At the same time, fast foods are found easily as street foods in Indonesia. Moreover, many parents are not aware of overweight and obesity as a health problem, but see child with excess weight as 'cute'.

Overweight and obese children are likely to develop increased risk factors for cardiovascular disease, such as hypertension, dyslipidemia, and impaired glucose tolerance.[7] Excess childhood weight may increase the likelihood of heart disease in adulthood because of the early establishment of these risk factors.[8]

There are few population-based studies on physical activity, dietary intake and overweight in school children in Indonesia. The published studies used different instruments to assess physical activity.[1,2] In this study, physical activity was collected using pedometers that are commonly used for researcher and practitioner for studying of adolescent. Pedometer are generally considered more practical in term of cost and data management associated with less complex data system.[9,10] Pedometer is also better for the children that hard to remember details about

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the pattern of their activities.[11] The objective of this paper was to study the association of total energy intake and physical activity with prevalence of overweight among Indonesian children, aged 6–12 years old. The hypothesis was that low physical activity, and high energy intake are associated with overweight.

METHODS

This cross-sectional, community based study was part of the South East Asian Nutrition Survey (SEANUTS),[12] conducted in Indonesia in 2011.[13] A multistage random sampling from district/sub district to village was used. The unit of the sample was household selected according to probability proportion to size. Details of the study design have been published previously.[12,13] The inclusion criteria of this analysis were children having complete data on dietary intakes, physical activity and body mass index for age z-score (BAZ) >-2.0 SD. By using the inclusion criteria, the total sample for this analysis was 1143 children. The data are representative for Indonesian children of that age. The study was a cross-sectional study to measure the prevalence of under and over nutrition in Indonesia, therefore the sample size determination using only α without considering power (β). The statistical formula to measure sample size as follow: $n = \{(1 - \alpha/2) P (1 - P)\}/d$, where P was prevalence of overweight 9.2%[2] and d=5%, design effect=2.

The study was performed following the guidelines of the Helsinki declaration. Ethical clearance for the study was granted from the Ethics Committee of the National Institute of Health Research and Development, Indonesia number LB.03.02/KE/6430/2010 and was registered in the Netherlands Trial Registry number NTR 2462. Written informed consent was obtained from parents prior to participation in the study.

Height was measured to the nearest 0.1 cm bare-footed using a wall mounted stadiometer. Weight was measured to the nearest 0.1 kg in light indoor clothing using a calibrated digital weighing scale. Body mass index (BMI) was calculated as weight (kg) divided by height (cm) squared. BAZ were calculated using the WHO software.[14] The children were categorized as normal weight if -2 SD <BAZ≤1 SD and as overweight if BAZ exceeded 1 SD. Children with height for age z-scores (HAZ) <-2 were classified as stunted.[15]

Physical activity (PA) was collected using a Digi-Walker pedometer that records the number of steps. Pedometer was used as follows 1) pedometer was set on zero and days, 2) pedometer was tied to the left or right of the child's belt/trousers/skirt, 3) pedometer was released when child was doing activities that cause the pedometer become wet, 4) after being fitted for 2 x 24 h, the data recorded in the number of steps in the questionnaire. PA was recorded for 2 consecutive days, and the average number of steps over these two days was used in the analyses. In some children (n=43) only one day steps counts were available and were used instead. The correlation coefficient between step counts of day one and day two was 0.8 (p<0.05). PA based on step counts was categorized into tertiles (low, moderate and high PA). Cut-off points for low PA was <11,636 steps for boys and <10,311 steps for girls, moderate PA was defined as 11,636–15,891 steps for boys and 10,311–14,070 steps for girls and high PA was defined as >15,891 steps for boys and >14,070 for girls.

A one day 24h recall was used to assess food intake including drinks and supplements. A combination of household measures (cup, spoon, rice ladle), weighing scale and food models were used to get better estimate the weight of food consumed. Enumerators also bought local foods consumed to weigh and analyze them. Mother or child caregiver together with the child were asked about the meals that were consumed in the previous 24 h. The results of the 24 h recall were converted into nutrient intakes, using the Nutrisoft Program developed by the Centre for Research and Development of Food and Nutrition.[16,17] Energy intake (EI) was categorized into adequate (≤100% RDA) and high (>100% RDA). Local Indonesian RDA values were used.[18]

Socio-economic and demographic data were collected using a structured questionnaires. Income level data were aggregated from household valuable possessions (e.g. house, cars, motorcycles, internet, etc.) and monthly income, savings accounts, and jewellery. Income was categorized into quintiles and listed as very low, low, modal, high and very high.

Data were analyzed using the Statistical Package for Social Sciences (SPSS) v. 17.0. Data were weighted using weight factors based on the population census 2011.[19] Distribution of continuous variables is expressed as mean and standard error (SE), and categorical variables are expressed as frequencies (%). Backward linear multivariate logistic regression analyses was performed to find the association between overweight/obesity and energy intake, PA, age, area of residence, mother's occupation, and income level. Interaction among independent variables in the model included particularly PA (3 groups) and EI (2 groups). Since multiple logistic regression used dummy, PA became 2 groups plus one reference (high PA), EI became 1 group plus one reference (≤100% RDA). Therefore, there are 2 interaction of low PA with EI >100% RDA and moderate PA with EI >100% RDA included in the data analysis.

RESULTS

The numbers and percentages of children characteristics in various categories are shown in Table 1. Mean age was 8.1±0.1 years. There were about equal numbers of boys and girls in the study population and the number of urban children was slightly higher than the number of rural children. Almost half of children came from lower income families. Mean energy intake was 65.6±0.7 % of the local RDA and 1055 (92.3%) children had energy intakes lower than RDA. Mean step count was 12,537±138. Mean HAZ was -1.29±0.03 resulting in 25.2% of the children being stunted and mean BAZ was -0.31±0.03, 11.2% of the children were overweight or obese.

Table 2 shows the mean energy intake and physical activity by age, sex, residence, nutritional status and SES group. The highest energy intake was at age 11 years and the 8 year old children had the highest step counts. Energy intake of urban children was higher than rural children, but their physical activity was lower. Overweight

children reported a higher energy intake than normal weight children and their physical activity was lower. Stunted children had lower energy intake and higher activity. Children from higher SES had higher energy intakes but their physical activity level was generally lower. 65.9% of the boys and 50.9% of the girls had step counts below 15,000 and 12,000 respectively.[10] Children of mother that had permanent job had higher energy intake as well as their PA.

After correcting for the confounding effects of sex, area of residence, mother's education, and SES, significant risk factors for being overweight or obese were low PA independently and interaction of moderate PA level and energy intakes higher than 100% of RDA. At higher age the risk of being overweight/obese was higher. Explained variance of the physical activity, energy intake, nutritional status, SES, sex, area of residence and mother's occupation to overweight was 21.0% (Table 3).

Table 1. Characteristics of the children

Variables	n	%
Sex		
Boys	586	51.2
Girls	557	48.8
Age (years)		
6	252	22.1
7	224	19.6
8	225	19.7
9	156	13.6
10	155	13.5
11	131	11.5
Residence		
Urban	606	53.0
Rural	537	47.0
Mother's occupation†		
House wife	654	57.7
Permanent job	98	8.7
Temporary job	380	33.6
Socio-economic status		
Very low	213	18.6
Low	187	16.3
Modal	264	23.1
High	235	20.6
Very high	244	21.3

†Missing values because some children were orphans.

DISCUSSION

Overweight and obesity is a complex, multi-factorial, chronic disease but ultimately overweight or obesity is the result from an imbalance between energy intake and energy expenditure.[20] The results of the present study confirm that children with low PA and the interaction between moderate PA and high energy intake have an increased risk for being overweight. The children participating in the analysis were about 50% subsample of the total SEANUTS population of that age as only in half of the children food consumption was assessed. Their physical characteristics were not different from the total sam-

Table 2. Energy intake and physical activity (step counts) by children characteristics

Variables	Energy intake (kcal)		Physical activity (step counts)	
	Mean	SE	Mean	SE
Age (years)				
6	1154[a]	22	12089[a]	227
7	1219[b]	24	12305[ab]	240
8	1218[b]	23	13610[c]	222
9	1175[ab]	28	13412[c]	255
10	1181[ab]	27	12194[ab]	251
11	1241[ab]	30	12434[ab]	262
Sex				
Boys	1209[a]	14	13329[a]	138
Girls	1181[a]	15	11999[b]	143
Area of residence				
Urban	1274[a]	15	12510[a]	140
Rural	1125[b]	14	12865[a]	141
Nutritional status (HAZ)				
Stunted	1125[a]	19	13458[a]	188
Non-stunted	1227[b]	12	12387[b]	117
Nutritional Status (BAZ)				
Normal weight	1185[a]	12	12848[a]	112
Overweight	1381[b]	35	12207[b]	267
Mother's occupation				
House wife	1200[a]	16	12467[a]	179
Permanent job	1290[b]	42	13510[b]	460
Temporary job	1134[c]	22	12398[c]	236
Socioeconomic status				
Very low	1089[a]	22	13302[a]	247
Low	1123[a]	24	12688[ab]	231
Modal	1194[c]	21	12929[ab]	214
High	1299[d]	24	11900[c]	224
Very high	1313[d]	25	12664[b]	214

HAZ: Height for age z-score; BAZ: Body mass index for age z-scores.
Values with different superscripts are significantly different.
ANCOVA was used with age, sex, residence as confounding variable if it was not dependent.

Table 3. ODDs ratios for factors associated with the risk of being overweight or obese

Variables	Label	Odd ratio	95% CI
Age (years)	Age of the child	1.2	1.1-1.4
Physical activity	High	1.0	-
	Moderate	1.7	0.9-3.0
	Low	3.4	2.0-6.0
PA1*EI	Interaction	4.2	1.9-9.3

PA: physical activity; PA1*EI: moderate PA* EI >100% RDA.
Corrected for sex, age, height for age (HAZ), dietary intake, area of residence, mother's occupation, and socio-economic status.
Explained variance 21.0%.

ple (results not shown) and also the prevalence of stunting and overweight and obesity was not different from that of the total population.[13] The percentage of children with an energy intake lower than the RDA was high. Low energy intakes have been reported in other Indonesian studies as well. The study showed that 44.4% of children consume energy below the minimum (<70% RDA).[2]

This study used pedometers (step counter) to assess physical activity. Step counts are a simple method to assess physical activity, showing a relatively high correlation (greater than 0.6) with oxygen consumption. Although physical activity can also be assessed by questionnaires,[11] in children who do not yet have the cognitive ability to remember details about the pattern of their activities, the use of questionnaires might result in large biases.

The mean step count per day was higher in boys than in girls which are also reported in the literature.[10] It might not be surprising that the average step counts were higher in the lower SES class. Children from lower SES families might have to walk to school instead of taking public transport or being dropped off by the parents and also leisure time activities might be more out-door based than indoor in children of lower SES. The average step count in Indonesian children was considerably higher than reported in SEANUTS Malaysia (13,379 and 12,007 in Indonesia compared to 9,708 and 8,339 in Malaysia for boys and girls respectively).[6,21] As average step count is inversely related to SES the generally lower SES in Indonesia compared to Malaysia (average GDP per capita per year in Indonesia was US$ 3,644 and in Malaysia was US$ 10,500 in 2013)[22] might at least partly explain this. However, also in Indonesia there was still a large proportion of the children below the minimum recommended steps of 15,000 for boys and 12,000 for girls.[10] The number of children below the recommended number of steps per day was higher in urban than in rural children (results not shown).

The higher step counts in stunted children compared to normal height children were surprising. It can be speculated that to walk the same distance stunted children need more steps because of their generally shorter legs. The lower step counts in overweight/obese children compared to normal weight children were not surprising. This might be because of a generally lower active life style but it could also be that the overweight/obese state limits their physical activity level. A systematic review[23] showed that sedentary behaviour was positively associated with weight status and a study of Hernandes et al[24] showed that physical activity status was highly correlated with the incidence of overweight among children and adolescents.

Overweight and obesity is the result of a long term positive energy balance, i.e. a situation in which more energy is consumed than spent.[20] When comparing energy intake and step counts across groups (Table 2), it seems obvious that in some groups intake and expenditure were not balanced. For example, the energy intake in overweight children was higher than in normal weight children but their step counts were lower. Also the pattern of energy intake and step counts along the SES groups indicates the likelihood of a disturbed energy balance across the socioeconomic classes. SES has also been associated with childhood obesity. Generally, in developed countries, a low SES is associated with a higher obesity prevalence, whereas in developing countries the opposite seems to be true.[25] In developing countries high income levels allow to buy an abundance of food and being overweight is often seen as a status symbol. In contrast, in developed countries the higher economic class is more educated and aware of the risks of being overweight/obese.

The risk factors for being overweight/obese as listed in Table 3 were not always found in previous studies. Some studies did not find a relation between energy intake and obesity, although this seems obvious.[26] Underreported food intakes by the oveweight/obese subjects might be a reason. Also the protective effect of stunting as found in this study is not always found by others. Popkin et al[27] and Hofman et al[28] reported that stunting was positively associated with overweight.

Twenty four hours recall was used in this study, even though that method had a limitation, we assumed that method can predict the energy intake because the food pattern in rural Indonesian people did not vary much because of market day that may lead to the availability of food and less ability to purchase food because of economy factor. It was easy to record them as there were not many food items consumed. In urban area usually people consumed as habitual food prepared. Only on special days or during the weekend, the family will serve a special meal. This study covered all days in a week in rural and urban as average pictures of individual profile as representative of Indonesian children. Moreover, the result of dietary recall was not directly associated with overweight and obesity in the analysis, but categorized into two groups, below to equal of RDA and above of RDA.

In conclusion, the present study shows that a higher energy intake than RDA and moderate activity increased the risk of being overweight/obese with a factor 4.2, whereas a higher step count, thus higher physical activity

level, lowered the risk considerably. Children of lower SES were less likely to be overweight or obese independent of energy intake and step counts. Also stunted children were less likely to be overweight or obese. Program intervention such as stimulating physical activity at school and in leisure time is needed to reduce overweight or obesity in children in order to prevent future adverse health consequences.

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AUTHOR DISCLOSURES

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