PHYSICAL BEHAVIOURS IN ADOLESCENTS THAT CONTRIBUTE TO OVERWEIGHT/OBESITY

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ABSTRACT

Physical behaviours research in adolescents is still limiting in regard of overweight/obesity. Physical behaviour according to World Health Organization Global School Student Health Survey (WHO-GSHS) had four components namely physical activity, active transportation, physical education and sedentary behaviour showed inconsistent results investigating the obesity/overweight epidemic. The objective of this study is to examine the physical behaviour and metabolic components in overweight/obese adolescents. A cross-sectional study was conducted from September to October 2019 involving healthy obese adolescents with overweight/obesity in Sidoarjo and Surabaya. The statistical analysis was test of normality for interval/ratio variables, descriptive, bivariate correlation and binary logistic regression. All the analysis were conducted using SPSS ver. 21 (IBM, US). A total of 109 subjects were recruited in this study, consisting of male (50.46%) and female (49.54%) adolescents. The mean age of the subjects were 15.13 + 1.46 years old. Adolescents with sufficient physical activity, physical transport, physical class and recommended screen time was 93.58%, 23.85%, 14.68% and 36.70% respectively. The overweight subjects were 63 (57.80%) and obesity was 46 (42.20%), and prevalent in male than female (65.22% vs. 34.78%, p=0.012). The prevalent of MetS was 53.21%, no significant difference of MetS distribution among male and female (p=0.506). Subjects with physically transport behaviour had lower risk of abdominal obesity by 0.266-times than subjects with physically immobile. Thus, physical behaviour score did not correlate with anthropometric parameters indicating to overweight/obesity and metabolic factors, but the component of physical behaviour, especially sedentary lifestyle correlated with anthropometric parameters and systolic blood pressure. Physical transport protected the adolescents to the present of abdominal obesity.

Keywords: *Adolescents, Overweight, Physical Behaviour, Metabolic Syndrome*

INTRODUCTION

Physical activity research in adolescents is still limiting in educational setting (Sluijs et al., 2022). Adolescents is a very important developmental stage in human life (Rahman, 2019), in which they experiences various changes physically and psychologically (Arruda et al., 2020), as it was a transitional stage from childhood to adulthood (Kanthi and Johnson, 2021). Adolescents are facing the health and health-related behaviour (Salam et al., 2016), such as unhealthy diet, smoking, and physical inactivity (Dang et al., 2022), sexual abuse and practices (Banvard-Fox et al., 2020), drugs and alcohol abuse (Shau and Zhou, 2022), mental health issue (Nebhinani and Jain, 2019), and many more, in which affecting their health in the future.

Adolescents also predicted to live under triple burden of health problems, including non-communicable disease (NCD) (Akseer et al., 2020), which was caused by the wrong food consumption and inactive physically (Biswas et al., 2022; Uddin et al., 2020a). Physical activity has been a health concern nowadays as more than 80% of adolescents had physical inactivity accompanied with longer screen time or sedentary life (Sluijs et al., 2022). Xu et al. (2020) using World Health Organization-Global School Student Health Survey (WHO-GSHS) describe physical behaviour as the four components namely physical activity, active transportation, physical education and sedentary behaviour, and only 6.6% of adolescents had combined those physical behaviour globally (Xu et al., 2020). It was stated that physical activity

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and sedentary behaviour are the two important of physical behaviour components corelated with the later health outcome (Burahmah et al., 2023), and only 14.9% adolescents met the sufficient physical activity guideline, 16.5% attending sufficient physical education classes (Zhan et al., 2021), and screen time for more than 2 h/day was increased globally (Peltzer and Pengpid, 2016). A study conducted in high school adolescents noted the prevalent of unrecommended screen time was 79.5%, and higher in males than females (84.3% vs. 76.1%, p=0.000), and the prevalent was higher in the highest economic class (De Lucena et al., 2015).

Physical activity has been correlated to the rise prevalent of obesity globally (Koliaki et al., 2023; Raiman et al., 2023) and cardiometabolic event, but the evidence is limited (Sluijs et al., 2022). The rise of obesity prevalent leads to the increase of chronic NCD burden, and remain a challenge for public health (Özdemir, 2015), as NCD is one of the causes of premature death (Pham et al., 2022). Obesity during adolescents could be used as the best predictor for adult obesity (Simmonds et al., 2016), as this period is one of three critical period which is classified by Dietz and Gortmaker (2001): prenatal, adiposity rebound and adolescence period (Dietz and Gortmaker, 2001). Obesity is caused by the energy imbalance in which the increased calorie intake not accompanied by increased calorie expenditure (Grace et al., 2022), due to insufficient physical activity (Kaul et al., 2023) and longer screen time (Pitanga et al., 2019). Here we conduct a study to examine the physical behaviour and metabolic components in overweight/obese adolescents.

METHODS

A cross-sectional study was conducted during September to October 2019 involving healthy obese adolescents with overweight/obesity to access the effect of physical activity on anthropometric and metabolic parameters, including MetS. The population was adolescents whom study in Sidoarjo and Surabaya aged 12-18 years old. The school inviting this study was chosen using a simple random sampling according to the information we got from Education and Cultural Department. The inclusion criteria were: willing to take part in the study by signing inform consent (parents). The subjects were excluded when they: consumed corticosteroid during 6 months before the study were conducted, underwent dyslipidemia medication for 3 months before the study were conducted, had antibiotic medication or hormonal therapy, smoking, consume alcohol or drugs, had infectious or autoimmune diseases, or had endocrine disorders and chronic disease such as CVD.

Anthropometric measurements including body height (seca 213), weight (seca robusta 815), waist circumference (seca 201), and hip circumference (seca 201). The anthropometric measurements were conduct when the subjects wear light clothes with no accessories. Blood was collected after the subjects fasted for 10-12 hours and the blood was stored in EDTA tubes and processed within 2 hours after blood sampling or stored at -80 degrees and then transported to the selected laboratory responsible for epidemiological study. Blood pressure was assessed in a sitting position **using** a digital tensimeter (Omron HEM 7140T). Obesity assessment was based on BMI-for-age z-score as design by WHO using WHO Anthroplus (offline version, WHO), overweight was determined when BMI-for-age z-score ≥ + 2.00 to + 3.00 SD, and obesity was determined ≥ +3 SD.

MetS was determined using the International Diabetes Foundation (IDF) criteria, abdominal obesity (waist circumference ≥ 90th percentile) accompanied by at least two other signs, namely: hypertriglyceridemia (triglyceride levels ≥ 110 mg/dL for adolescents aged < 16 years old, and ≥ 150 mg/dL for adolescents < 16 years old), hyperglycaemia (fasting blood glucose or FBG levels ≥ 100 mg/dL for adolescents ≥ 16 years old and ≥ 110 mg/dL for adolescents ≥ 16 years old), hypertension (systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg), and low level HDL-c (HDL-c levels < 40 mg/dL for adolescents < 16 years old and HDL-c < 50 mg/dL for adolescents ≥ 16 years old) (Magge et al., 2017; Zimmet et al., 2007).

According to the World Health Organization-Global School Student Health Survey (WHO-GSHS), physical behaviour comprised of 4 major categories, namely: physical activity, active

transportation, physical education and sedentary behaviour (Xu et al., 2020). Physical activity, the adolescents with the physical activity at least 1 h/ day was categorised as physically active, weight as 1 (Pechtl et al., 2022). Active transport, the adolescents with at least 3 day of walking or bicycling to or from the school were categorised as active transport, weight as 1 (Liu et al., 2021; Xu et al., 2020). Physical education, the adolescents were categories as physical education when they attending the physical education class for 5 or more days, scores as 1 (Zhan et al., 2021). Sedentary behaviour was described as spending screen time for more than 3 h/day (Pechtl et al., 2022; Starks et al., 2023; Xu et al., 2020).

The study has been obtaining the ethical approval number 1360/KEPK/VII/2019, approved by the Health Research Ethics Committee of Dr. Soetomo Referral Hospital at July 31st, 2019. The statistical analysis was test of normality for interval/ ratio variables, descriptive analysis (presented as percentage and mean value), bivariate correlation and binary logistic regression. All the analysis were conducted using SPSS ver. 21 (IBM, US).

RESULTS AND DISCUSSION

A total of 104 adolescents were conclude this study. The prevalent of physical behaviour was summarized in **table 1**.

Adolescents with sufficient physical activity, physical transport, physical class and recommended screen time was 93.58%, 23.85%, 14.68% and 36.70% respectively. Those four aspects are the most often behaviour that contributing in preventing NCD, with the prevalent of physically active was 30.43% in other study. The prevalent of physically inactive in adolescents ranged from 2.3% to 93.5%, and more prevalent in girls. Sedentary behaviour, which marked with screen time activity, also had a high prevalent, with more than 50% (Filho et al., 2014). The prevalent of physical education ranged from 16.5% to 24.2% (Uddin et al., 2020b; Zhan et al., 2021), while physical transport ranged from 37.0% to 41.9% (Aguilar-Farias et al., 2018; Liu et al., 2021).

The adolescents perception on regard of physical behaviour was a sex-related (Aguilar-Farias et al., 2018) and age-related (Salvo et al., 2020), especially in physical activity aspects (Aguilar-Farias et al., 2020). Other found that sedentary behaviour was related with age and gender specific, with being female as the risk factor of this behaviour (Aguilar-Farias et al., 2020). Adolescents are one of important stage of life which need to be concerned as their behaviour pattern and habituation may attribute to the next health issues such as NCD (type 2 diabetes, cardiovascular disease, cancer and obesity) (Akseer et al., 2020)

Table 1. Adolescent physical behaviour based on WHO GSHS

Variables	n	%
Physical activity for at least 60 min/day in a week		
None (0 day)	7	6.7
1 day	32	30.8
2 days	25	24.0
3 days	14	13.5
4 days	9	8.7
5 days	7	6.7
6 days	6	5.8
7 days	9	8.7
Physical transport (bicycle or walking) in a week		
None (0 day)	71	68.3
1 day	7	6.7
2 days	5	4.8
3 days	5	4.8
4 days	5	4.8
5 days	4	3.8
6 days	4	3.8
7 days	8	7.7
Physical education class in a week		
None (0 day)	8	7.7
1 day	65	62.5
2 days	7	6.7
3 days	8	7.7
4 days	5	48
More than 5 days	15	14.4
Screen time during a day		
Less than an h/day	11	10.6
1-2 h/day	29	27.9
3-4 h/day	39	37.5
5-6 h/day	18	17.3
7-8 h/day	6	5.8
More than 8 h/day	6	5.8

Table 2 summarized the subject characteristics. The overweight subjects were 63 (57.80%) and obesity was 46 (42.20%), and prevalent in male than female (65.22% vs. 34.78%, p=0.012), which mean that being male more likely to have

Table 2. Subject characteristics based on the physical activity categories

Subject characteristics	x ± SD	Min-max
Age, years-age	15.13 ± 1.46	12.00-18.00
Gender		
- Male	55	50.46%
- Female	54	49.54%
Body weight, kg	90.21 ± 14.99	54.80 - 130.70
Body height, cm	145.53 ± 25.16	94.30 - 179.00
BMI, kg/m^2	33.95 ± 4.68	26.80 - 56.90
BMI-for-age z-score	2.88 ± 0.53	2.00 – 4.26
Nutritional status		
- Overweight	63	60.6%
- Obesity	46	44.2 %
MetS	58	55.8%
Abdominal obesity	96	92.3%
Hyperglycemia	3	2.9%
Low HDL-c	51	49%
Hypertriglyceridemia	45	43.3%
Hypertension	72	69.2%
Waist circumference, cm	99.10 ± 11.64	74.00 - 139.00
Hip circumference, cm	111.34 ± 9.17	87.00 - 150.50
GDA, mg/dL	86.50 ± 6.47	66.00 -110.00
Total cholesterol, mg/dL	171.03 ± 33.27	92.00 - 271.00
HDL-c, mg/dL	43.37 ± 7.79	25.00 - 67.00
LDL-c, mg/dL	112.79 ± 28.33	40.00 - 188.00
TG, mg/dL	110.31 ± 55.63	28.00 - 267.00
Systolic blood pressure, mmHg	127.38 ± 12.88	100.00 - 163.00
Diastolic blood pressure, mmHg	82.24 ± 9.43	60.00 - 108.00
Physical behaviour score	8.86 ± 1.25	1.00 - 21.00
Physical activity score	2.71 ± 2.02	0.00 - 7.00
Physical transport score	1.27 ± 2.23	0.00 - 7.00
Physical education score	1.89 ± 1.61	0.00 - 5.00
Screen time score	3.03 ± 1.25	0.00 - 5.00

overweight/obesity by nature. The prevalent of MetS was 53.21%, no significant difference of MetS distribution among male and female (p=0.506). Obesity prevalent is greater in boys than girls among paediatric population (Shah et al., 2020), which was in line with this results. However, other found inconsistent outcomes regarding sex when it access using BMI, male : female ratio of obese adolescents was 1 : 1.5 (Iduoriyekemwen et al., 2023). The sex difference in obesity prevalent brought up several hypotheses such as societal idea in body weight, feeding practices and biological influences such as hormone and body composition (Shah et al., 2020). Also female adolescents had higher awareness in their physical image (Pawloski et al., 2023). Other study found that MetS was more prevalent in male, ranged from 1.4 to 55.8%, and affecting them with overweight/obesity (Orsini et al., 2023). The risk for having MetS in boys was 6.57-folds, and combination with obesity increased the risk by 12.70-fold (Mehairi et al., 2013).

Table 3 summarized the correlation between physical behaviour, physical activity, physical transport, physical education and screen time with anthropometric and metabolic components in adolescents. It was showed that physical behaviour did not correlate with the anthropometric parameters and MetS components. Physical activity correlated positively with waist circumference (r=0.231, p=0.016), which was support by a

Table 3. The correlation between physical behaviour score and metabolic parameters

Anthropometric and Metabolic Variables	Physical behaviour		Physical activity		Physical transport		Physical education		Sedentary behaviour	
	r	p	r	p	r	p	r	p	r	P
BW, kg	-0.007	0.943[a]	0.218	0.023[a]	-0.144	0.238[a]	0.149	0.122[a]	0.387	0.000[a]
WC, cm	-0.021	0.832[a]	0.231	0.016[a]	-0.090	0.353[a]	0.130	0.177[a]	0.379	0.000[a]
BMI, kg/m^2	-0.119	0.216[a]	0.094	0.332[a]	-0.198	0.039[a]	0.107	0.266[a]	0.412	0.000[a]
BMI-for-age z-score	0.001	0.993[a]	-0.133	0.169[a]	-0.122	0.205[a]	0.224	0.019[a]	0.322	0.001[a]
GDA, mg/dL	0.048	0.617[b]	-0.067	0.490[b]	0.039	0.689[b]	-0.054	0.578[b]	-0.154	0.164[b]
TC, mg/dL	-0.004	0.967[a]	0.047	0.625[a]	-0.001	0.988[a]	0.003	0.973[a]	0.091	0.380[a]
HDL-c, mg/dL	-0.133	0.167[a]	0.067	0.487[a]	-0.059	0.542[a]	-0.128	0.184[a]	0.023	0.826[a]
LDL-c, mg/dL	-0.030	0.758[a]	0.034	0.725[a]	-0.056	0.566[a]	0.046	0.635[a]	0.109	0.826[a]
TG, mg/dL	0.140	0.145[b]	0.041	0.673[b]	0.129	0.181[b]	-0.078	0.423[b]	0.033	0.752[b]
SBP, mmHg	0.032	0.739[b]	0.108	0.262[b]	0.021	0.830[b]	0.090	0.355[b]	0.259	0.011[b]
DBP, mmHg	-0.088	0.362[b]	0.118	0.220[b]	-0.016	0.866[b]	0.073	0.452[b]	0.047	0.654[b]

[a]Pearson correlation; b Spearman Rho correlation

cohort study, the physically active subjects had lower waist circumference than physically inactive subjects (Gariballa et al., 2023). Other also supported this finding, in which stated obesity was correlated with high leisure time (Joshi et al., 2023), and that physically active was correlated with BMI (Malik and Chatterjee, 2023).

Physical transport correlated negatively with BMI (r=0.198, p=0.039), which was in line with other (Joshi et al., 2023). It was found that passive transport increase the risk of being obese by 5.6-folds (Mizwar et al., 2022). Also, children who walk or bicycle to school or go home had higher physical activity with better cardiovascular fitness than them with passive transport (de Jesus et al., 2021), even increase speed-agility among boys and muscle strength of lower body muscle in girls (Villa-González et al., 2015). The Latine countries design cut-off points for physical transport by walking to prevent overweight/obesity in adolescents as 7,304 and 5,162 of daily steps for girls and boys respectively (Ferrero-Hernández et al., 2022). In adults, active transport lowered men BMI by 0.97-1.10 points, and women 0.72-0.87 points (Flint et al., 2014).

A study found no correlation between physical transport with body weight reduction or BMI (Lee et al., 2008), but several study showed the effectiveness of physical transport promotion in enhancing physical activity levels during childhood in preventing NCD events in the future (Lam et al., 2023), as no significant results was found in regards of active transport. This inconsistency also marked by Andersen et al (2009), only 3 study found the association between active transport with body weight loss, while a study found that active transport was associated with higher BMI as the lack of evidence to support the findings (Andersen et al., 2009). The effect of physical transport on health may be a long-term event, so it can't be observe in a cross-sectional study, as shown in a study, that boys with active transport for 2-years had lower BMI and skinfold than those with the passive one, but this difference did not correlated with BMI or overweight status (Rosenberg et al., 2006).

Other also supported this findings (Bhargava et al., 2016). But physical education correlated positively with BMI-for-age z-score (r=0.224, p=0.019). In a qualitative study, physical education remains the only source of physical activity which was done by adolescents (Hills et al., 2015), and physical education can help obese student to get the better health and fitness via fitness approach and healthy lifestyle counselling (Syafruddin et al., 2023).

Sedentary behaviour was correlated with body weight (r=0.387, p=0.000), waist circumference (r=0.379, p=0.000), BMI (r=0.412, p=0.000), BMI-for-age (r=0.322, p=0.001), and systole blood pressure (r=0.259, p=0.011). A study showed that obesity was more prevalent to those who ate junk food while doing screen time (Jain et al., 2023). In the sedentary behaviour scoring system, we reverse

the score described by Xu et al. (2020) in order not to confuse us in reading the results.

A study based on GHSH questionnaire showed that screen time for > 3 h/day increased the risk of overweight and obesity by 1.42-fold (Arfines et al., 2020). The negative effect of screen time also seen in other result, in which the male subjects with screen time more than 6 h/day had abdominal obesity, but no correlation with BMI and hypertension (Singh et al., 2023). Body fat measurements (abdominal, triceps and subscapular fat mass) also found the significant correlation between screen time with body fat (Alamolhoda et al., 2020). A study also found that screen time was correlated with SBP and DBP ($r=0.423$, $r=0.413$, $P<0.05$), and each hour of screen time (in week) increases the hypertension risk by 1.18-fold (Stabouli, 2022).

CONCLUSION

Physical behaviour score did not correlate with anthropometric parameters indicating to overweight/obesity and metabolic factors, but the component of physical behaviour, especially sedentary lifestyle correlated with anthropometric parameters and systolic blood pressure. Physical transport protected the adolescents to the present of abdominal obesity.

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