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Fundamental Movement Skill Approach to CombatChildhood Obesity in Surabaya, Indonesia: Potential Effects of Video Games Based Exercises (Exergaming)

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Abstract:

The study aims to observe the effect of moderate intensity exergaming on mastering of fundamental movement skill and reduction in body mass index (BMI) in overweight and obese children in Surabaya, Indonesia. The participants were 17 primary school students, aged 6-12 years. All participants had a BMI above percentile 85 (overweight and obese) and performed 12 sets of moderate intensity exergaming for four weeks, 3x/week, 30-40 minutes/session. The variables were fundamental movement skill, body weight, BMI, body fat percentage, and prediction energy expenditure. They were taken 3 days prior first exercise (pre-test) and after last exercise (post-test) except for energy expenditure. Prediction of energy expenditure were taken in first and last of exergaming session. The result showed, there was improvement in component jumping of fundamental movement skill, but not in others component. There were also significant decline on body weight, BMI, and body fat percentage, but not in energy expenditure. The conclusion of this research is the regular moderate intensity exergaming for 4 weeks can help children to improve their fundamental movement skill and reduce BMI.

Keywords: fundamental movement skill, exergaming, moderate intensity, obese children, body mass index.

I. INTRODUCTION

Overweight and obese childrenare likely to stay obese into adulthood and more likely to develop non-communicable diseases such as cardiovascular disease, metabolic disease, insulin resistance, and Type II Diabetes Melitus (T2DM) at younger age (Dandona, Aljada, Chaudhuri, Mohanty, & Garg, 2005). Overweight and obesity, as well as their related diseases are highly preventable. One of the WHO reccomendation is to implement comprehensive proggrames that promote physical activity and reduce sedentary behaviours in children and adolescent.

Active participation in physical exercise is essential to maintain the energy balance as well as to increase child's motoric and physical ability, social, cognitif, and psycology. Ability to perform fundamental movement skill (FMS) is a basic for mastering more complex and

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specialized movement which is required at various physical activity, physical games activity and sports (Cohen, Morgan, Plotnikoff, Callister, & Lubans, 2014). Pre-primary and primary school years is a critical period for development FMS and children who do not mastery in FMS are more likely to experience failure in motor domain and less likely to partipicate in sport and games during childhood or adolescent (Hardy, King, Farrell, Macniven, & Howlett, 2010; D.R. Lubans, Morgan, Cliff, Barnett, & Okely, 2010).

In recently years, trend in exercise in children was inspired by technology development for active video gaming or called exergaming;is type of physical exercise combine with video games resulting a fun activity for children. Various video game developer such Konami, Nintendo, Sony, and Microsoft have been released various model of exergaming on market (Ni Mhurchu et al., 2008; Peng, Lin, & Crouse, 2011). VGA *(active games/active video games, Xergames)* is an interactive games.

The aims of this study is to observe the effect of moderate intensity exergaming (video games based exercise) on mastery of FMS and reduction of body weightin overweight and obese children in Surabaya, Indonesia.

II. METHOD

The design of this research was experimental study. The participants were 17 healthy children, consisted of 7 boy and 10 female students aged 6-12 years old, BMI was above 85 percentile (classified into overweight and obesity), without medical history of cardio metabolic, respiration, and musculoskeletaldiseases which inhibited the ability to do physical exercise. This composition is representative of primary school students at Surabaya City, Indonesia. This research was already approvedby Ethical Commision of Medical Faculty, Airlangga University.

Participants performed exergaming using Microsoft X Box 360 Kinect console. The games type were Kinect Dance and Kinect sports with medium intensity (equal to 3-6 Mets ; 1 Mets equal to 3.5 mL/kg min and controlled using Actiheart® device). Kinect sports consisted of various sport games such as track and field, soccer, table tennis, boxing, volley ball, bowling; while the Kinect Dance refered to various dance games inside Kids Dance games. Participants were free to choose desired games to play but still maintain a balance movement between upper and lower body. Exergaming were performed 3 session/week in alternate day, 12 sets (for 4 weeks), 30–40 minutes per session at Exergaming Laboratory in Department of Physiology Medical Faculty Airlangga University.

Anthropometric measurement including body weight, height, waist girth and skin thickness fold were measured 3 days prior to exercise and 3 days after exercise. Body weight was measured with light clothes on mass balance Onemed ZT150 (resolution 0,1 kg). Height was measured to the nearest 0.1 cm without shoes(wall mounted stadiometer). Waist girth was taken on the umbilical level using the girth tape. Body Mass Index was calculated using formula of body weight (kg) divided by height square (m^2). Skin thickness fold was

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measured using caliper fold (Eiken type caliper fold Lafeyette tipe 01128) resolution 1mm. Measurement was performed at 2 areas, triceps and subscapula. Body fat percentage was determined by Slaughter formula which define elsewhere(Graves, Ridgers, & Stratton, 2008) and has been proved for the reliability and validity against gold standard DEXA(Ridley & Olds, 2001). The participants asked not to change their diet.

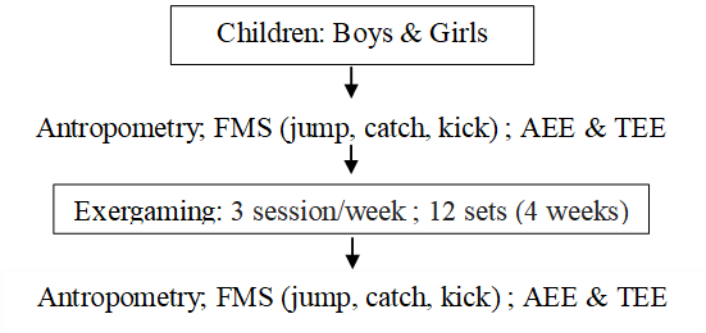

Figure1. Research procedure.

FMS performance was analyzed using GUI application device which connected to 2 kinect sensors. Data analyzed using pre determined criteria and expressed using scoring system, range between 0-7. There are 3 movement which is analyzed qualitatively during this reseach. Those are catch, jump (vertical) and kick. Vertical jump was also measured quantitatively by using Jump DF (Takei®, model TTK-5414) and presented in cms.

Prediction energy expenditure during exercise was measured using accelerator sensor Actiheart® complete with heart rate and activity counter (acceleromovement). Energy expenditure data presented in kJ/minute unit.

III. RESULTS AND DISCUSSIONS

Results

The average age of participantsin this study was (8.30±1.55) years and average BMI was (26.39±4.17) kg/m^2. The data were normal in distribution and there were no significant differences between boy and girlparticipants (table 1).

Table1. Demographic characteristic of research participants

Characteristics	**Sex**	**n**	**Average**	**Normal distribution Shapiro Wilk (p)**	**T Test (p)**
Age (years)	Boys	71	8.73 ± 2.12	0.105 0.637	0.357
	Girl	0	8.01 ± 1.02		
Body height	Boy	7	131.24±	0.380	0.59

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Characteristics	Sex	n	Average	Normal distribution Shapiro Wilk (p)	T Test (p)
(cms)	s Girl	10	8.82 129.18 ± 6.73	0.191	3
Body weight (kgs)	Boys Girl	7 10	46.30 ± 1.41 42.92 ± 7.95	0.247 0.621	0.537
Body Mass Index (kg/m^2)	Boys Girl	7 10	26.76 ± 4.62 26.12± 4.05	0.543 0.500	0.768

A significant improvement in one of tree FMS components (jump-vertical movement) was observed (fig. 2). In addition, boys have higher jump score quality than in girls. Quantitative analysis of vertical jump showed there were also improvement of explosive power in jumping for both girls and boys (table 2). After 12 sets of exergaming, both boys and girls lost weight and reduction in BMI (table 3).

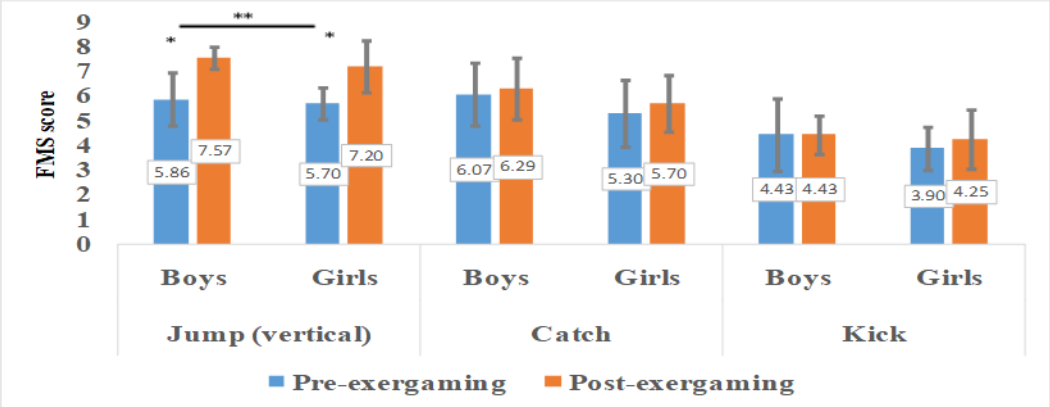

Figure 2. Fundamental movement skills before and after exergaming treatment.
* significant ($p<0.05$); **significant boys vs girls

Table 2. Vertical jump before and after exergaming

Sex	N	Pre-exergaming (cm)	Post-exergaming (cm)	Paired T Test (p)
Boy	7	23.28±1.89	25.57 ± 2.93	0.019*
Girls	10	23.20±2.29	25.50±3.50	0.014*

* significant ($p<0.05$)

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Table 3. Anthropometric measures before and after exergaming

Characteristic	Sex	n	Pre-exergaming	Post-exergaming	Paired T Test (p)
Body Weight (kgs)	Boy	7	46.30 ± 14.12	44.98 ± 14.10	0.010 *
	Girl	10	42.92 ± 7.95	41.49 ± 7.87	0.001 *
BMI (kg/m^2)	Boy	7	26.76± 4.62	25.16 ± 4.28	0.001 *
	Girl	10	26.12± 4.05	24.31± 3.78	0.001 *
%BF	Boy	7	37.82 ± 6.92	31.96 ± 5.20	0.009 *
	Girl	10	31.81 ± 4.93	28.97 ± 2.92	0.073

* significant ($p<0.05$)

Despite a decrease in body weight and BMI, %BF, there were a reduction of body fat in boysbut not in girl (table 4).

It can be observedthere was a small improvement of AEE and TEE, however the results were not significant, this probably because children adaptability to game types thus increase their competency to the movement (Fig. 3). There is no significant difference between pre test and post test ($p>0.05$) both in boy and girls.

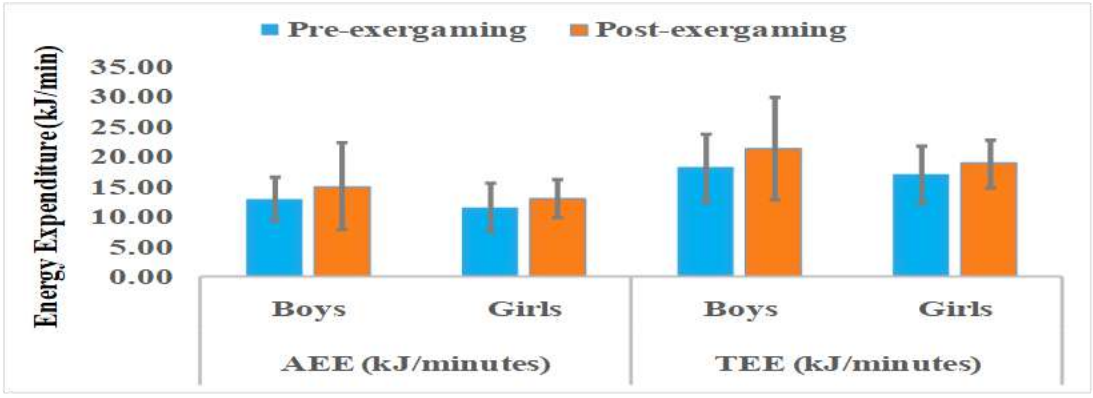

Figure 3. Average value of energy expenditure during exergaming activity (AEE)and total energy expenditure (TEE)

No corelation was observed between the improvement of FMS proficiency and reduction of BMI in either boy or girl participants (Fig. 4 and 5).

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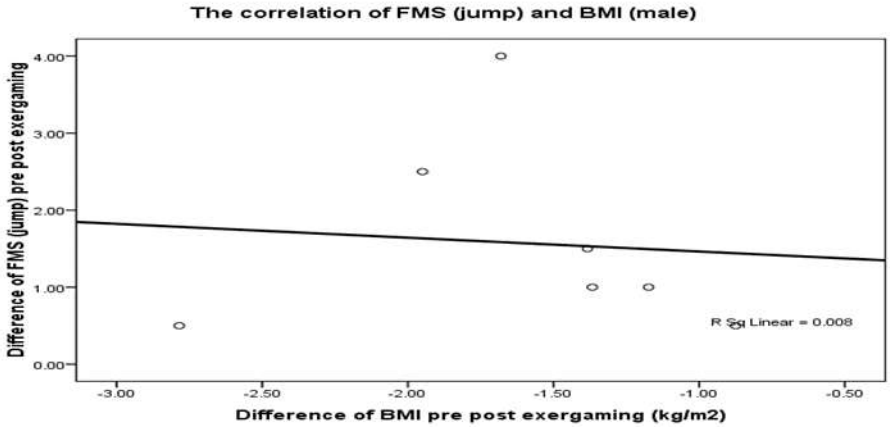

Figure 4. The correlation of FMS and BMI in boy participants. Spearman correlation -0.088 and p=0.425

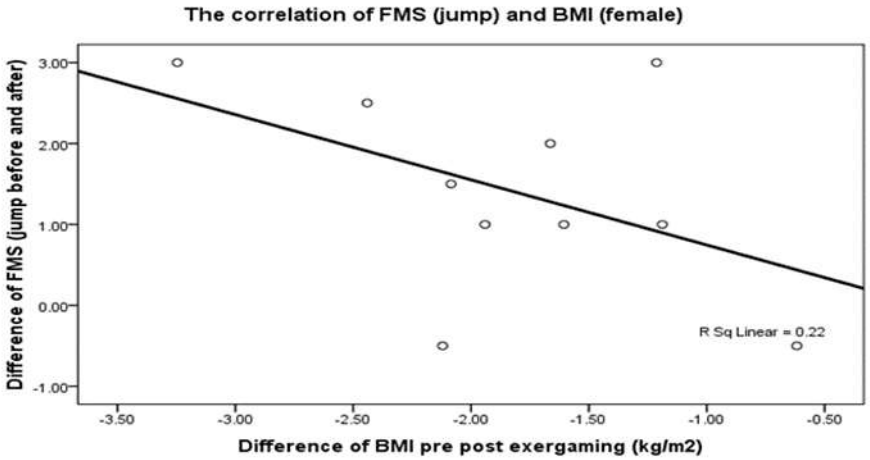

Figure 5. The correlation of FMS and BMI in girl participants Spearman correlation -0.469 and p=0.86

Discussion

The three FMS components in this research (jump, kick and catch), there was only improvement in jump. In spesific developmental milestones for FMS, children achieve mature stage of catching and kicking in earlier age than jumping. In contrary to this, one study showed children do not mastered FMS in predetermined sequence, however they are influenced by the learning program and in particular the interplay between them and learning environment(Straker & Abbott, 2007). Exergaming environment in this research did not support a game which properly manipulate or control an object. For example, in volleyball or soccer games, the ball is fake and the children who play this game did not necessary to have proper control for hit, throw, kick or catch the ball. In addition, it is probably because jump maybe easier to learn and not as complex as kick and catch which require manipulation or control the object. In addition, type of other weakness of exergaming is not include strenght factor during exercise. For example during throw

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movement at exergaming virtual environment is not include those factor. Thus people who play with small power or poor ball control still have very good score at those games (Thornton et al., 2014).

This finding is consistent with other study 12 weeks of low to high intensity conventional exercise. A review of exergaming has also shown moderate potention of exergaming to decrease BMI, both as single behavior therapy or in combination with various treatment such as diet, medicine, and other therapy (Peirson et al., 2015).

This finding are supported by other study which analyze sex differences of the exercise effect on body fat which showed that men generally lose more fat than a woman (Bagley et al., 2016). The reasons of this differences is not clearly understood, however it probably related with relative muscle mass, skeletal muscle contractile and metabolic characteristics. Metabolic rate and lipid oxidation remain high after exercise in male, whereas in female is almost negligible(Maddison et al., 2011). The higher exercise intensity, the faster of subcoutaneous fat mass and body weight reduction. Higher exercise intensity will lead to visceral fat mobilization by induce more lipolysis hormone, increase energy expenditure and fat oxidation as well as a shift tendency to negative energy balance (Irving et al., 2009). However, there are still mix results about the sex diffrences on the effects of exercse to body fat, several research showed has shown a greater reduction of fat mass in boys compare to girls (Graves et al., 2008; Graves, Stratton, Ridgers, & Cable, 2007; Ridley & Olds, 2001; Straker & Abbott, 2007; Tan, Aziz, Chua, & Teh, 2002)], girlparticipants experienced more reduction than boy (Tan et al., 2002) and other research stated no difference between both gender (Maddison et al., 2011).

The energy expenditure during exergaming with medium intensity in this research indicated increasing 4 -5 fold times compare to sedentary activity that amount only 4,4 (1.5) kJ/min and almost equal or even higher compare to energy expenditure of children during conventional exercise with medium intensity for example walking at speed 3 mil/hour at amount 17.8 KJ/min, skipping, jogging, stepping ladder(Bagley et al., 2016; Hardy et al., 2010; WHO, 2016). This indicated that exergaming is comparable to the conventional exercise in the energy expenditure. However, to maintain the amount of energy expenditure, it is required to play with variable type and difficulty of games.

These results are contrary to across sectional study which which found inverse association between FMS and BMI(Hardy et al., 2010). A more recently systematic review ofhealth benefits of FMS also suggests an inverse correlation between FMS and BMI, although the results are inconsistent accross the studies (David R Lubans, Morgan, Cliff, Barnett, & Okely, 2010). This might be because only component of jump which improved after exergaming. The more comprehensive proficiency in FMS will lead the children to increase their time in physical activity (David R Lubans et al., 2010) and lose more.

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In this research, we also noted that exergamingengagement and continuity of exercise is really important. Parents and teachers played important role in supporting children participation in exercise. norms which have existed.

IV. CONCLUSION AND SUGGESTIONS

Physical exercise using medium intensity exergaming for 4 weeks in overweight and obese children has potency to improve FMS and effect BMI reduction. We suggest to performed various games variety to facilitate various development of other component of FMS.Further research is required with prolonged duration to observe the more effects on FMS and BMI and body fat, and variation of games to analyse which games is more pronounced effects for FMS and BMI.

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