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Physical Fitness and Executive Functions in Preschool Children

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Abstract

Neurophysiological maturity plays a crucial role for the school adjustment of preshool children. It also affects Executive Function (EF) as the ability to regulate behavior and to control children's emotions. The children' neurophysiological maturity is influenced by the physical fitness level. Children with better fitness can do better physical and psychological activity than children who are not fit. This study aims at revealing the relationship between physical fitness and EF as well as each of its components towards preschool children. It is also to measure the role of maternal education level and family income as a moderator of the relationship between physical fitness and EF in preschool children. Subjects in this study were 224 children (male = 110, female = 114) aged 60 months - 84 months in Magelang City. The results showed that physical fitness is positively influence to EF in which the more fit child will achieve better EF abilities. This study also found that maternal education level and family income were not moderators of the relationship between fitness and EF. The results of this study can have implications to raise an understanding on the benefits of physical activity and fitness for children.

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INTRODUCTION

Preschool age is a period at which children experience many changes both physically and psychologically. The characteristics of preschool children include the development of self-concept, egocentric, curiosity, imagination, feeling, internal controls, thinking, language skills, behavior and environmental learning (Barnett, 2008). Preschool age is also an important and critical time for children to learn as well as to prepare them before joining elementary school. When the children enter formal school, they will face with the context of the physical environment, processes, types of interactions, social groups and even rules, that are different from their previous experiences (Ladd, Herald, & Kochel, 2006).

Efficient and successful adaptation for children in school depends on children's readiness to follow systematic learning and it is related to executive functions (EF) (Krivolapchuk & Chernova, 2012). EF is a group of mental processes needed by someone for having concentration and giving attention. It is also required to carry out meaningful activities using automatic responses, or usually called instinct or intuition (Diamond & Lee, 2011). EF allows a person to mentally play with ideas; think first before acting; find something new, face unexpected challenges; resist temptation; and stay focused (Diamond, 2013).

EF is required to concentrate and think before doing a new movement (unfamiliar), not the routine(Miyake et al., 2000; Monette, Bigras, & Guay, 2011). So, EF is a noble cognitive ability, which is very important in the process of problem solving and planning, especially if the individual facing with a new situation or unpredictable condition that requires rapid response. EF consists of three core components, namely; inhibition, working memory and set shifting (Diamond, 2013; Miyake et al., 2000; Monette et al., 2011). Those three points form the basis for high-level of EF skills, such as reasoning, problem solving, and planning (Diamond, 2013).

There are various factors related to the development of EF, one of which is children fitness level. Several studies have examined the relationship between fitness condition and the ability to perform EF tasks. Based on teacher observation, it is found that if children's fitness levels began to decline, their concentration and attention will be disturbed. It indicates a strong relationship between fitness and class performance (van der Niet, Hartman, Smith, & Visscher, 2014). Based on the research results on children aged 7-12 years, Van Der Niet (2014) also found that physical fitness was affected to EF and academic achievement.

Children fitness can not be achieved if they lack of physical activities. When they have limited activities in schools without other physical activity after school hour. It means they mostly spend their day by sitting in classroom. In fact, the amount of time sitting and the amount of exercise affects the chances of obesity. This trend has been studied by the Centers for Disease Control, US. that reports obesity gives a bad effect for health, especially for cardiovascular disease (Fedewa & Ahn, 2011; Lambourne et al., 2013).

Moreover, children's physical activity impacts on neurophysiological maturity as well as other development aspects. Neurophysiological maturity is important for early childhood to adjust in schools and it contributes to EF as the ability to control their behavior and emotions. It implies that physical health influences children's thinking ability and children's social and emotional aspects (Blair, 2002).

Children's neurophysiological development is influenced by their physical fitness. It indicates that fit children can do better physical and psychological activity. Healthy or fit children (as measured by aerobic fitness test) had better scores on their academic achievement test, and better scores on EF (Buck, Hillman, & Castelli, 2008). Similar to this findings, Neuro-electric research on children's cognitive activity reveals that fit children (based on bigger aerobic fitness test related to maximum oxygen consumption) perform more accurate works on EF tasks compared to the less fit children (Hillman, Buck, Themanson, Pontifex, & Castelli, 2009; Pontifex et al., 2011).

One theory that can be referred to explain the relationship between physical fitness and EF is physiological sensitivity hypothesis, also known as the cardiovascular sensitivity hypothesis. It states that regular exercise (either aerobic or non-aerobic exercise such as muscle resistance or games without aerobic components) cause short and long-term changes in the brain area that are important for learning and memory. It result in increased cerebral blood flow (Etnier, Nowell, Landers, & Sibley, 2006). The research that examined the relationship between children's aerobic fitness with the structure and function of basal ganglia in 9-10 year-old children, showed that children with higher fitness presented better results in completing EF tasks. Physically fit children had a bigger dorsal striatum volume as a determining factor of cognitive control and behavioral disorders (Chaddock et al., 2010).

Based on the results of his research on 139 subjects aged 58-81, it was found that higher levels of fitness are associated with: (a) better performance on task inhibition and spatial working memory (SPWM), and (b) bigger gray mater volume in some areas including the dorsolateral prefrontal cortex (DLPFC). The inferior volume of the right frontal gyrus and precentral gyrus mediates the relationship between cardior respiratory disease (CRF) and task inhibition, and the bilateral section of DLPFC intervenes the relationship between CRF and SPWM. These results indicate that the specific area of DLPFC related to inhibition and SPWM. Thus, fitness can affect cognitive function by reducing brain atrophy in the target area of healthy adults (Weinstein et al., 2012).

Those studies above have shown a close link between fitness and EF. However, the relationship between physical fitness and EF and each of its components in preschool children aged 5-7 years is not known for certain, especially in what age the physical motor and the children's brain structure development are still considered as immature. Therefore, this study is trying to find out the relationship between physical fitness and EF as well as each of its component in preschool children.

This study also measured the level of maternal education as well as family income, which are believed to influence children's cognitive abilities. A number of studies show that one of the most important environmental influences in children's cognitive development is the level of parents' education. Parents with higher education create a better environment to stimulates children's intellectuals (Bornstein, 2013). It has been shown that highly educated parents (professionals) have different ways of interaction with their children, especially their language use. A highly educated mothers speak with more vocabulary production, and provide more reading activities to their children (Hoff□ Ginsberg, 1991).

Moreover, Childhood socio-economic conditions also affect the life status because of its influence on education and public health (Fritzell & Ritakallio, 2010). Socio-economic status, usually attributed to income, education and employment, has been associated with various kinds of life outcomes covering cognitive abilities, academic achievement, physical and mental health (Sirin, 2005). Therefore, this study also investigate the role of maternal education and family income as a moderator of the relationship between physical fitness and EF in preschool children.

METHODS

The research subjects were 224 children consisting of 110 males and 110 females from B Kindergarten aged 60 - 84 months. It involved four early childhood schools in Magelang city. The schools determination was done by cluster random sampling, i.e. taking representatives from each existing geographical area randomly. Since Magelang was divided into three regions, south, central and north so that the selected schools represented each area of Magelang city. The four schools included ABA 4 (South Magelang), Bhayangkari Kindergarten (Central Magelang), Kindergarten of IT Asy Syafa 1 (Central Magelang) and Kindergarten of Pembina (North Magelang). This research has received approval from the research ethics committee of the Faculty of Psychology Universitas Gadjah Mada number 1736/SD PL.03.01/IV/2018.

The physical fitness scores of each subject were obtained through a composite score based on the measurements results from five components, namely cardiorespiratory, explosive strength, flexibility, morphology, and agility.

The cardiorespiratory component was measured by maximal oxygen consumption using a multistage fitness test (Mackenzie, 2005). This test consisted of 21 levels where each level was approximately one minute. Each level covered a series of running back and forth as far as 20 meters where the initial speed of running was 8.5 km/ hour and increased by 0.5 km/ hour on each level. In this study, the distance of running the child was changed to 10 meters because it adjusted to the footsteps of preschool children (Prasepty, Sugiharto, & Rumini, 2017). The score was the value of vo2max based on the norm. The higher the score obtained by the child showed the higher cardiorespiratory capacity.

The musculoskeletal component was measured by two things, namely explosive strength and muscle flexibility. The explosive strength of children was calculated using a standing board jump (Ortega, Ruiz, Castillo, & Sjöström, 2008; Ruiz et al., 2006). This test examined the components of leg muscle strength, either indoors or outdoors. The test procedure was the sample standing on a repulsion board with knees bent to an angle of approximately 45 degrees and both arms straight back. Then, the sample rejected forward with the strongest leg and lands on two legs. The scores were from the length of (cm) the child's jump from the pedestal to the landing point. The longer the jumping distance of the children indicated the higher explosive power.

The flexibility was measured using sit and reach test (Mackenzie, 2005). The purpose of this test was to monitor the flexibility of the back muscles and hamstring muscles. A table to sit and grab or bench with a ruler (in cm size). The initial position sat on the floor, the child was barefoot, and the legs were straightened. Hands reached forward and pushed fingers along the table as far as possible. The distance between the middle finger and the table taken as the child's score. The score referred to distance of the distance (cm) from the end of the table to the middle finger of the child. The farther distance of the child reach, the higher flexibility of children's muscles.

The morphological component was seen through the children Body Mass Index (BMI) by looking at body weight and height with a meter unit for height and a kilogram unit for body weight. BMI was measured by calculating the body weight in kilograms divided by the square of height in square meters (kg/ m^2) (Vale, Trost, Duncan, & Mota, 2015).

The components of motor skills were examined through agility measurement using the 4x5m shuttle run test (Monyeki, Koppes, Monyeki, Kemper, & Twisk, 2007). In this test, the child was asked to run back and forth as quickly as possible with a distance of 5 meters in 4 times, the result as the achieved time in seconds. The smaller the time achieved by the child, indicated the better agility. The score was the speed (in seconds) of the running until the stop, with a distance of 5 meters back and forth in 4 times. The smaller time of the child get, the higher motor skill ability was obtained.

This part was measured using EF test developed by (Willoughby & Blair, 2016). In this study, a single EF score was obtained through composite scores from the three EF components, namely inhibition, working memory and cognitive flexibility. The inhibition ability was examined using the spatial conflict arrow test while working memory capacity was using the pick the picture test, and cognitve flexibility or shifting was employing something's the same.

In the spatial conflict arrow test, the child was given a card with two black circles, one on the right and one on the left. Then, the child was shown a row of arrows pointing right and left. The child was asked to touch the black circle according to the direction of the arrow in the picture. If the arrow was pointing to the right, the child must immediately touched the black circle on the right, and if the arrow was pointing to the left, the child must immediately touched the dark circle on the left. Children were given 37 picture items, including 12 arrows that were not in accordance with the direction of the arrow. The score was the number of items that the child responded appropriately. Each correctitem was rated 1 and the wrong answer was rated 0. The higher score obtained by the child showed the better ability in the control inhibition.

In pick the picture session, children were shown several pages of images in sequence, where each page consisted of several series of images whose the contents were same as the previous page but had different order of image positions. The task of the child was to designate one of the images on each page but which had not been previously appointed, so that later all the images will be appointed. There were 30 picture series items that the child must select ranging from 2 - 6 series of images. The correct answer was when a child did not designate a picture that has been previously chosen. Each item answered correctly was rated 1 and the wrong answer was 0. The higher the score was collected indicated better WM's ability.

In something's the same part, child was shown a pair of images that have one dimension of similarity (for example, the two images were the same color, or both images had the same size). Next, the third image was presented and the children were asked to identify which of the first two images were similar to the new picture. This task required children to turn their attention from the initial label to a new dimension of similarity (for example, from color to size). There were 20 picture card items where the correct answer was given a score of 1 and incorrect respond was 0. The higher value got indicated better cognitive flexibility.

The maternal education level referred to the number of years spent by the mothers in attending formal education. The data on maternal education levels were revealed through questionnaires filled out by the parents.

The family income was the average monthly income earned by the parents. The parent income data were obtained through questionnaires filled by parents.

RESULTS AND DISCUSSION

The results of this study were elaborated through two stages, firstly by displaying a description of measurement data and, then, the data were analyzed through statistical analysis to determine the correlation among variables. The description of measurement data was displayed the mean scores, standard deviation, and the minimum and maximum scores of each measurement. The description of measurement data can be seen in **Table 1**.

In order to measure the correlation among the measured variables, Pearson's product moment correlation coefficient formula was used to find out whether there is a relationship of each variable. The measured variables included EF and each of its component as well as physical fitness and each of its component, maternal education level, and family income. Besides, it was included variables of child age and gender to find out the relationship between the two things with EF and all of its components, as well as physical fitness and all of its components. The results of the correlation among the measured variables can be seen in **Table 2**.

Based on **Table 2**, it was found that the children age was related to their EF ability where the higher age of the child indicated the higher EF score. The children age was also related to muscle strength (explosive power). The higher age of the children showed the more distance of the jump. In case of gender variables, it was found that gender was associated with score inhibition, cardiorespiratory level, and muscle strength. Boys were able to complete the task of inhibition better than girls. Boys also had higher cardiorespiratory levels and muscle strength than girls.

Family income was related to cardiorespiratory levels, BMI, and children's physical fitness. The higher family income showed the lower cardiorespiratory level, BMI, and physical fitness of the children. Meanwhile, the education level of the mother was not related to EF and fitness, as well as all of its components.

Physical fitness was related to EF and WM and CF components. The higher level of physical fitness of children showed the higher ability of EF, WM and CF of children

In each fitness component, the strength and agility were found to be associated to EF, as well as components of inhibition and WM. The bigger muscle strength and the more agile children indicated the higher EF score, inhibition, and WM. BMI was linked with EF and inhibition. The better BMI indicated the better value of EF and inhibition. Meanwhile, the cardiorespiratory and flexibility components were not related to EF and all of its components.

Furthermore, this study also measured the role of variables in the level of maternal education and family income as moderators of the relationship between physical fitness and EF using linear regression analysis. It aimed at determining whether the relationship between physical fitness and EF was supported by the level of maternal education and family income. The analysis results for the maternal education role as a moderator of the relationship between physical fitness and EF can be seen in **Table 3**. Meanwhile, the analysis results of the family income role as a moderator of the relationship between physical fitness and EF presented in **Table 4**.

Based on **Table 3**, it was known that there is no increase in the value of R Square. Also, the changes in the value of F did not increase with a significance value> 0.01. It implied that maternal education levels did not influence the relationship between physical fitness and EF. So, the mother's level of education is not a moderator of the relationship between physical fitness and EF of the children.

Based on **Table 4**, it was known that there is an increase in the value of R Square of 0.015. However, there is no increase in the value of F with a significance value> 0.01. It suggested that family income does not influence the relationship between physical fitness and EF. So, family income is not a moderator of the relationship between physical fitness and EF of the children.

There are several things found based on the results of this study. Firstly, the children's age is related to their EF ability. This finding supports a number of previous studies regarding the development of EF. According to Casey, Tottenham, Liston, & Durston (2005), cognitive development reflects brain development. In early childhood, the cognitive processes appear and develop rapidly, so that in this period the child's brain also develops very quickly. During the early age period, primary cortex areas, such as the auditory and visual cortex, as well as connecting areas like the prefrontal medial cortex, have high levels of synapse density and experience a dynamic period of synapse release at different synapse lines (Huttenlocher & Dabholkar, 1997).

In the age of six, the total brain volume of children increases and reaches 95% of the brain of an adult (Lenroot & Giedd, 2006). Based on the results of MRI study, (Giedd et al., 1999), in the age of four years, the volume of white matter continued to increase, while the volume of gray matter in the frontal and parietal parts increased and peaked during the middle childhood after it began to decline. During infancy and early age, the total volume of white matter is bigger than gray matter (Matsuzawa, 2001). Since the age of five years, an increase in the volume of white matter in each part of the brain continues to increase along with age development (Taki et al., 2012).

The escalation of the white matter are associated with an increase in myelinization (Satoshi Tsujimoto, 2008). Myelinization in the main pathways of brain starts from the post-natal period, with the maximum development in the first two years of life, and continues into childhood and adolescence (Gao et al., 2009). White matter maturity which includes myelinization and increased complexity of nerve circuits supports the development of cognitive functions and also changes in gray matter (Tau & Peterson, 2010).

Gogtay et al., (2004) explain that the primary and secondary areas of the frontal lobe reach maturity earlier than the connecting area of the prefrontal cortex, as measured by a decrease in gray matter thickness. Although the cortex is thinning, the prefrontal portion enlarged along with age growth, compared to the area around the central sulcus or posterior medial surface (Sowell, 2004). It shows that there is an increase of myelinization in the lower cortex layer together with age development, which is caused by expansion of the brain and thinning of the cortex. Each pathway in the frontal white matter can be identified early during the post natal period and continues to develop at preschool age (Hermoye et al., 2006).

A number of studies in preschool children showed activity in the prefrontal cortex during their work on EF tasks including, firstly, the presence of similar activity in adults within the prefrontal lateral cortex of children aged five and six years while working on memory tasks (Tsujimoto, Yamamoto, Kawaguchi, Koizumi, & Sawaguchi, 2004); secondly, there is activity in the prefrontal medial cortex in children aged 4.5 years while working on memory tasks and control inhibitions (Wolfe & Bell, 2004); thirdly, from the age of three to four years, children show improvement when working on conceptual switching tasks, and also by increased activity in the inferior prefrontal section (Moriguchi & Hiraki, 2011).

Executive function may be a unitary factor in early childhood, and then develop into three different components when the child begins to be mature (Miller, Giesbrecht, Müller, McInerney, & Kerns, 2012). Based on Piaget's theory, the first signs of executive function development is approximately 8-9 months, namely in the Sensorimotor Stage of 4 period when the baby begins to reach something or showing activities to reach the goal. At this stage, the baby performs two different structures of action (schemes), and learns to coordinate the two separate schemes to get a result. At the age of 2 years, the inhibition mechanism starts working, 3-5 year-old children begin to develop cognitive flexibility to solve problems and make changes to different activities. Furthermore, at the age of 6 years, their working memory and speed processing begin to develop well (Barkley & Lombroso, 2000). This ability continues to develop during childhood.

Neural circuits in the prefrontal cortex are an important part of EF (Shimamura, 2000). Unlike other brain regions that responsible for motor and sensory processing, speech & language development, and attention, the prefrontal cortex begins to be mature in late adolescence. During childhood, when the prefrontal cortex is immature, progressive and regressive changes such as myelination and synaptic pruning occur simultaneously and are influenced partially by children's experience (Best, 2010). According to Diamond (2006), along with age development, children and adolescents show better competence when working on tasks of EF components and other tasks that require coordination of several EF components (for example, manipulating information in memory while inhibiting various disturbing stimuli).

This finding also supports the previous research conducted by Hermahayu & Wimbarti (2017) that there was no difference between children aged 4.5, and 6 years in the measurement of inhibition and WM. Meanwhile, in case of CF, there is a difference between children aged 4.5, and 6 years. As explained by a number of studies that CF develops after inhibition and WM. So, by growing older, CF is getting better, and EF has finally grown better too.

The age of the child is also associated with cardiorespiratory. Even, some experts suggest that age affects almost all components of physical fitness. Cardiovascular endurance tends to increase in childhood until twenty years with a maximum of 20 to 30 years old (Ministry of Health of the Republic of Indonesia, Directorate General of Public Health Development, Directorate of Community Health Development, 1994). The resistance will decrease together with age about 8-10% per decade for inactive individuals while for active one is 4-5% per decade (Sharkey, 2010). It shows that the increasing age result in better child's cardiorespiratory fitness, and it will only decline after the age of 30 years.

The age differences are also related to muscle strength, as children motor or movement development. Motor skills develop in a definite order, and age norms are often used to measure the developmental progress (Johnson et al., 2012).

It shows that by growing older, the muscles of the child's motion become more mature, and their motoric development is certainly more complex, different from the previous.

Secondly, gender only relates to inhibition, and it is not related to EF and the components of WM and CF. Boys showed better inhibition ability than girls. Previous research conducted by Hermahayu and Wimbarti (2017) showed that, for boys and girls, there were no differences in inhibition, WM, and CF. Another study showed a different thing, it was done by (Yamamoto & Imai-Matsumura, 2019) who measured self-adjustment behavior, inhibition control, and working memory of five-year-olds. The results of the study showed that there were no significant differences between men and women in the three EF components.

Cardiorespiratory level and children muscle strength are also related to gender. According to Armstrong et al. (2006), women's aerobic endurance is about 20% lower than men of the similar age. It is caused by hormonal differences that make women have lower hemoglobin concentrations and bigger amount of body fat. Women also have less muscle mass than men where it influences muscle strength between men and women.

Thirdly, family income is not related to cardiorespiratory levels and children's physical fitness, but positively associated to BMI. It shows that the higher family income, the lower level of cardiorespiratory and children fitness with the better body mass index. It is caused by the low physical activity among children from high income family. Children from high income family tends to have a complete facilities that actually reduce their children physical activity, such as regular school pick-up, gadgets that make children less interested in outdoor physical activity as well as cable TV with a variety of interesting channels. In addition, the parents with high income tend to give more pocket money to their children, and their money usually spend to buy ready-to-eat foods which lack of nutrition.

Moreover, the results of this research show that physical fitness is related to EF and the components of WM and CF. It supports the study results stating that physical fitness is closely related to EF (Van Der Niet, 2014; Buck, 2008; Hillman, et al, 2009; Pontifex, et al, 2011). It is also in line with the research results from Weinstein et al. (2012) who found that higher levels of fitness were associated with spatial working memory (SPWM). It shows that physical fitness occurs in children related to brain activity that regulates WM and CF. WM is more dependent on the dorsolateral prefrontal cortex (Eldreth, Patterson, Porcelli, Biswal, & Rypma, 2006). The fit children has bigger volume of dorsal striatum in the prefrontal cortex than less fit children (Chadock et al., 2010).

The strength components have been proven to be associated with total EF score, as well as inhibition and WM. It has been explained previously that motor skills develop in a definite order, and age norms are often used to measure developmental progress (Johnson et al., 2012). According to (Hurlock, 2001), motor development is a physical growth through coordinated central nerve, nerve, and muscle activity. As getting older, the muscle control skills are getting better because motor skills cannot be separated from controlling muscles and nerves. So that, the ability to control this movement is related to the ability to control the mind, think before acting, and avoid impulsive action.

The agility component was also associated with EF, as well as inhibition and WM. Agility is a movement that coordinates between speed, balance and skill. According to Best (2010) there are several things that can be used to explain the relationship between motor skills and EF. Firstly, such complex activities require many similar cognitive processes as EF tasks completion. Cognitive processes in complex movements, for example managing strategies and directing certain movements or behaviors when facing new experiences or certain demands of movement. The acquired skills when doing this movement can be used to do EF tasks. Secondly, such complex physical activity also requires skilled and complex movements, which are directly dependent on the prefrontal nerve circuit that supports EF. Seeing cognitive demands that exist when performing complex motor coordination tasks (eg two-handed coordination tasks, or learning motor skills), results from the presence of prefrontal cortex (PFC) during complex motor activities, and physiological changes in the hippocampus and cerebellum.

Sixth, BMI is associated with EF and inhibition. This finding supports the results of Palupi, Sulaeman, Ploeger's (2016) study which found that there was a significant positive relationship between BMI and memory in children aged 5-6 years. It is also in accordance with the results of (Reinert, Po'e, & Barkin, 2013) who showed that, in children, bad BMI status related to low EF, especially inhibitory control ability.

In this study, the unpredictable result was that cardiorespiratory and flexibility were not related to EF and all of its components. This is different from several studies stating that cardiorespiratory fitness is related to EF's ability caused by an escalation of blood flow to the brain which triggers brain oxygenation and activates brain structure to regulate EF. This dissimilar result can happen due to other factors that are considered to be more crucial to EF's abilities, for example, the participation of children in various cognitive development activities in schools and outside schools, maternal care, as well as the number of android-based cognitive game applications played by the children in their gadgets.

This study also indicates that the level of maternal education and family income was not a moderator of the relationship between fitness and EF of children. It is believed that there are other factors that more closely related to support the relationship between fitness and EF. Some of the factors consist of children involvement in other non-physical activities and the parenting strategies to provide EF stimulation for children. Both factors are not measured as the limitation in this study.

CONCLUSION

Based on the results and discussion, it can be concluded that fitness is related to EF in preschool children. Some components in fitness are also related to a number of components from EF. The study also found that maternal education and family income did not support the relationship between physical fitness and EF among preschool children. The children in this modern era tend to lack of physical activities such as outdoor play, and the influence of unhealthy eating habits. Thus, the results of this study can have implications to raise an understanding on the benefits of physical activity and fitness for children.

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Table 1 Description of measurement data

	Mean	Std. Deviation	Minimum	Maximum
Age of child	69,3348	4,74171	57	80
Mother's education level	13,6808	2,612	9	22
Family income	3446875	2157267	700000	11000000
Inhibition	29,8661	5,95046	5	37
Working memory	23,6071	3,59086	8	32
Cognitiveflexibility	11,192	2,77783	3	15
EF	2,3403	0,3324	1,42	3
Cardiorespiratory	23,4353	2,00275	19,2	29,1
Fleksibilitas	23,3339	7,84414	12	125
Power	76,0514	28,57228	7,8	133,2
Body mass index	15,78	2,4776	11,11	25,45
Agility	-11,0566	6,97869	-84,3	-7,2
Fitness	-0,2359	1,05324	-4,87	0,99

Correlations

	Inhibition	Working memory	Cognitive flexibility	EF	Cardiorespiratory	Fleksibilitas	Kekuatan	IMT	Kelincahan	Kebugaran
Umur anak	0,121	0,096	0,117	,156*	0,081	0,01	,177**	0,019	0,036	0,028
Jenis Kelamin	-,170*	-0,058	0,013	-0,095	-,260**	0,054	-,139*	-0,06	-0,116	-0,062
Tingkat pendidikan ibu	0,088	-0,095	-0,019	-0,003	0,006	0,099	-0,033	0,118	-0,005	-0,039
Pendapatan keluarga	0,097	0,03	0,07	0,096	-,162*	0,056	0,028	,222**	-0,033	-,142*
Inhibition		,333**	,169*	,699**	0,092	0,028	,322**	,206**	,204**	0,071
Working memory			,294**	,685**	0,028	-0,026	,314**	0,022	,176**	,177**
Cognitive flexibility				,745**	-0,055	-0,106	0,008	0,109	0,102	,133*
EF					0,023	-0,054	,273**	,168*	,220**	,172**
Cardiorespiratory						-,161*	0,024	-,143*	-0,109	,194**
Fleksibilitas							-0,003	0,053	0,046	-0,012
Kekuatan								-0,106	,239**	,420**
IMT									0,061	-,498**
Kelincahan										,230**
Kebugaran										

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3 Summary Model of the relationship of Fitness with EF and Mother's Educational Level

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	,172[a]	,030	,025	,32816	,030	6,793	1	222	,010
2	,172[b]	,030	,021	,32890	,000	,003	1	221	,958

a. Predictors: (Constant), Fitness

b. Predictors: (Constant), Fitness, family income

Table 4 Summary Model of the relationship of Fitness with EF and family income

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	,172[a]	,030	,025	,32816	,030	6,793	1	222	,010
2	,211[b]	,045	,036	,32637	,015	3,439	1	221	,065

a. Predictors: (Constant), Fitness

b. Predictors: (Constant), Fitness, family income