COMPARISON OF ANTROPOMETRY AND PHYSICAL ABILITIES BETWEEN TRAINED AND UNTRAINED INDIVIDUALS IN SECOND GROWTH PHASE

Idzam Kholid Akbar[1], Bambang Purwanto[1], Hari Setijono[2]

[1]Sports Health Sciences Master Program, Faculty of Medicine, Universitas Airlangga, [2]Faculty of Sports Science, Surabaya State University, Surabaya, Indonesia

ABSTRACT

The growth and development of the body goes through two phases of rapid growth. First phase (0-5 years) and second phase (10-17 years). This study aimed to compare anthropometry and physical abilities between trained and untrained individuals in the second rapid growth phase (adolescence). This research method used analytic observational with cross sectional design. The sample study used adolescents aged 14 years old, consisted of trained adolescent groups (n=25) and untrained adolescent groups (n=32), with categorized throught the International Physical Activity Questionnaires (IPAQ). Each group measured height, weight, chest circumference, vital lung capacity (VC), oxygen saturation (SpO2), heart rate resting, heart rate exercise, and VO2Max. The results of the different test between trained and untrained groups with a significance level of p<0.05 showed there were significant differences in body height (p=0.000), VC (p=0.000), SpO2 (p=0,001), heart rate rest (p=0.000), and VO2Max (p=0.000). There were no significant differences in body weight (p=0.053), chest circumference (p=0.226), and heart rate exercise (p=0.242). As a conclusion, anthropometry and physical abilities of trained individuals was greater than the untrained individuals in the second rapid growth phase (adolescence).

Keywords: Adolescent; adolescence; rapid growth; physical abilities; VO2Max

ABSTRAK

Pertumbuhan dan perkembangan tubuh melewati dua kali fase pertumbuhan cepat, fase pertama (0-5 tahun) dan fase kedua (10-17 tahun). Penelitian ini bertujuan membandingkan antropometri dan performa fisik antara individu terlatih dengan tidak terlatih pada fase pertumbuhan cepat kedua (remaja). Metode penelitian ini menggunakan analitik observational dengan rancangan cross sectional. Subjek penelitian merupakan remaja usia 14 tahun, terdiri dari kelompok remaja terlatih (n=25) dan kelompok remaja tidak terlatih (n=32) dengan pengkatagorian melalui kuesioner International Physical Activity Questionnaires (IPAQ). Setiap kelompok dilakukan pengukuran tinggi badan, berat badan, lingkar dada, kapasitas vital paru (VC), saturasi oksigen (SpO2), denyut jantung istirahat, denyut jantung latihan, dan VO2Max. Hasil Uji beda antara kelompok terlatih dengan tidak terlatih taraf signifikansi p<0.05 menunjukkan bahwa terdapat perbedaan yang signifikan pada tinggi badan (p=0.000), VC (p=0.000), SpO2 (p=0,001), dan denyut jantung istirahat (p=0.000), VO2Max (p=0.000). Tidak terdapat perbedaan yang signifikan pada berat badan (p=0.053), lingkar dada (p=0,226), dan denyut jantung latihan (p=0,242). Kesimpulan penelitian ini adalah antropometri dan performa fisik individu terlatih lebih besar daripada individu tidak terlatih pada fase pertumbuhan cepat kedua (remaja).

Kata kunci: Remaja; masa remaja; pertumbuhan cepat; performa fisik; VO2Max

Correspondence: Idzam Kholid Akbar, Sports Health Sciences Master Program, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia. Phone: 085749608555. E-mail: kholidzam@gmail.com

INTRODUCTION

Technological advances have a negative impact on the patterns of growth and development of adolescents today. Shifting patterns of physical activity is thought to inhibit the growth of upper-segment anthropometry, which tends to reduce the physical abilities of adolescents (Anglin 1991). Growth is related to quantitative changes, an increase in size and structure.

The child not only becomes physically bigger, but the size and structure of the internal organs and brain increases. According to Tanuwidjaya (2002), growth is the increase in size and number of cells and intercellular tissue, meaning the increase in physical size and body structure in a partial or overall sense. Development is the increased ability in the structure and more complex body functions in an orderly and predictable patterns, as a result of the maturation process (Hurlock 1998).

The growth and development of the body takes place in stages, including the neonatal period, infancy, preschool, prepubertal, adolescence, and adulthood. In adolescence, there is a very rapid acceleration of weight and height called Adolescent Growth Spurt. The growth and development of the body goes through two phases of rapid growth. The first rapid growth phase occurs in infancy to preschool, aged 0-5 years. The second rapid growth phase occurs in adolescence to adulthood, aged 10-17 years. The growth and development of the body between the two phases of rapid growth takes place slowly (Tanuwidjaya 2002). This is why physical activity is needed to optimize growth in the Growth Spurt phase. The second rapid growth phase has an orientation in the upper body segment, starting from the growth and development of the head to the pelvis. One part of the body that grows and develops in the second rapid growth phase is the chest cavity, lung, and heart. The growth of the chest cavity, lung and heart increases the work capacity of the cardiopulmonary system in providing and distributing oxygen throughout the body (Bogin 2012).

The growth and development of the body is influenced by internal and external factors. The physical activity patterns is one of the external factors that is thought to affect the growth and development of the body (Tanuwidjaya 2002). Trained individuals have measurable and well-planned physical activity patterns, while untrained individuals have random and unmeasurable physical activity patterns.

Physical exercise carried out in accordance with training principles will cause anatomical adaptation, where changes occur both anatomically and physiologically. Increased ability and work capacity of various body systems, including the endocrine system, musculoskeletal system, metabolic system, respiratory system, cardiovascular and blood. So that in trained people, cardiorespiratory endurance (VO2 Max) will increase.

Comparison of upper body segment anthropometry and physical abilities between trained individuals with untrained individuals in the second rapid growth phase (adolescence) provide an overview of Indonesia's generation for the next ten years. Because differences in trained with untrained individuals in adolescents have never been conducted, research is needed to find out the comparison of upper body anthropometry and physical abilities between trained with untrained individuals in

the second rapid growth phase. This study attempts to answer the phenomenon of a progressive decreasing physical abilities of Indonesian teenagers. Where anthropometric variables and physical abilities measured include: (1) height, (2) body weight, (3) chest circumference, (4) vital lung capacity, (4) oxygen saturation (SpO2), (5) heart rate (HR) rest and heart rate (HR) exercise, (6) VO2Max.

MATERIALS AND METHODS

This study uses a quantitative approach with analytic observational type with cross sectional design. This research was carried out on 29-31 August 2018 at Karitas 3 Junior High School in Surabaya. Subjects in this study were trained adolescents and untrained adolescents aged 14 years, based on birth 31 August 2003-31 December 2004, at Karitas 3 Surabaya Junior High School randomly selected as research respondents. Subjects are grouped into trained individuals and untrained individuals based on physical activity patterns (Mets/week) with categorized throught the International Physical Activity Questionnaires (IPAQ). The trained individual groups is adolescents who have physical activity patterns more than or equal to (3000 Mets/week). The untrained individual groups is adolescents who have physical activity patterns less than (3000 Mets/week). There were 25 subjects of trained groups, and 32 subjects of untrained groups.

The study was carried out two days. The first day, the IPAQ questionnaire was distributed and informed consent was given to the respondents submitted to their respective trustees. The questionnaire was collected and received again by the researcher on the same day. After collecting the questionnaire, all of the subjects were measured for height, weight, and chest circumference. The second day, the subjects were entered into 2 groups, trained adolescent groups and trained adolescent groups with categorized throught the International Physical Activity Questionnaires (IPAQ). Both groups were measurements of vital lung capacity, oxygen saturation and HR rest. After that, each group was measured VO2Max with Multistage Fitness Test (MFT). Subjects were given a 5 minute warm up direction then MFT measured. Level achievements are considered fail (maximum level) if the subject fails to reach the 20m distance limit twice. Immediately after failing to complete the MFT level, HR exercise will be measured.
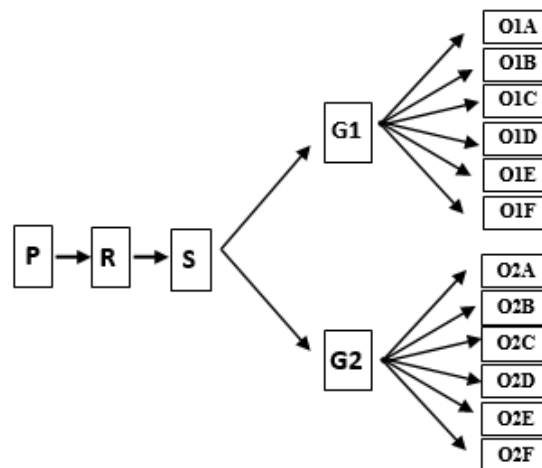
Fig. 1.   Research plan. P: Population, R: Randomization, S: Research Subject, G1: Trained adolescent groups, G2: Untrained adolescent groups, O1: Measurement of trained adolescent groups, O1A: Height and weight measurement G1, O1B: Chest circumference measurement G1, O1C: Vital lung capacity measurement G1, O1D: Oxygen saturation (SpO2) measurement G1, O1E: HR rest and HR exercise measurement G1, O1F: VO2Max measurement G1, O2: Measurement of untrained adolescent groups, O2A: Height and weight measurement G2, O2B: Chest circumference measurement G2, O2C: Vital lung capacity measurement G2, O2D: Oxygen saturation (SpO2) measurement G2, O2E: HR rest and HR exercise measurement G2, O2F: VO2Max measurement G2

Physical activity pattern

The physical activity pattern in this study is physical activity that is commonly carried out in the daily lives of individuals expressed in Mets/week using the IPAQ instrument. Classified as trained and untrained groups. Classed into trained individual groups if score IPAQ 3000 Mets/week, untrained individual groups if score IPAQ less than 3000 Mets/week.

Height and weight

Height was measured using stadiometer with an accuracy of 0.1 cm. Measurements were made with the position of the flat plane (Frankfort horizontal plane). Body weight was measured using stadiometer with an accuracy of 0.01 kg.

Chest circle

Chest circumference was measured using a flexible measuring tape with a band width of not more than 0.7 cm. The measurements are carried out and recorded at the end of the usual expiratory phase, on the xifoideus bone (substernal incisura).

Vital lung capacity

Subjects took a maximum breath and exhaled as completely as possible on a moderate basis, to the maximum blowing. Using a spirometer, it is carried out

at medium/normal air pressure with liter and percent (%) units.

Oxygen saturation

Oxygen saturation was taken one hour before performing maximum physical activity as pretest data and immediately after performing maximum physical activity as posttest data. Oxygen saturation (SpO2) was measured using a pulse oximeter by inserting a finger into the device and the results will appear in units of percent (%).

HR rest and HR exercise

HR was measured using polar type H10 belt.

VO2Max

VO2Max was measured by Multistage Fitness Test. The MFT is carried out on 20 m running track by running back and forth by using cassette instructions. The subject is considered complete after failing to complete the MFT level twice.

Data analysis technique

Analysis of research data using the SPSS series 20 program which includes statistical data as follows: (1) descriptive statistical test; (2) distribution normality test and homogeniety test, (3) different test.

Table 1. Subject descriptive data and different test

Variables	Group 1 (n=25)	Group 2 (n=32)	(p) Value
Age (years)	14.33 ± 0.33	14.37 ± 0.33	
MET	3706.32 ± 409.18	1554.16 ± 633.33	
Height (cm)	168.04 ± 4.76	158.13 ± 5.96	0.000*
Weight (kg)	57.56 ± 13.52	50.50 ± 13.28	0.053
Chest circumference (cm)	77.20 ± 6.99	74.69 ± 8.19	0.226
Vital Capacity/VC (liter)	3.17 ± 0.32	1.88 ± 0.21	0.000*
Oxygen saturation/SpO_2 (%)	93.92 ± 2.31	95.31 ± 0.59	0.001*
HR rest (bpm)	85.44 ± 1.83	95.22 ± 1.85	0.000*
HR training (bpm)	199.24± 7.28	197.09 ± 6.41	0.242
VO_2Max (ml/kg/min)	37.41 ± 5.40	28.92 ± 4.48	0.000*

Note: G1 = Trained adolescent groups
       G2 = Untrained adolescent groups
       * = Significantly different between two groups (p> 0.05)

RESULTS

The results of the normality test with Shapiro Wilk showed that the variables of height, weight, chest circumference, VC, HR rest, HR exercise, and VO2Max in both groups were normally distributed (p>0.05), so the difference test used parametric tests (independent sample t-test). Whereas the final SpO2 variable in both groups was not normally distributed (p<0.05), so the different test used nonparametric test (Mann Whitney test).

The homogeneity test showed variable height, weight, chest circumference, VC, HR rest, HR exercise, and VO2Max in both groups (p>0.05). Whereas the final SpO2 variables in both groups were not homogeneous (p <0.05).

Different test with significance level of 0.05 (p<0.05), it can be concluded that: (1) There was significant differ-ence in height, VC result, final SpO2, HR rest, and VO2Max between G1 and G2; (2) There was no significant difference in body weight, chest circum-ference, HR exercise, between G1 and K2.

DISCUSSION

The research showed a significant difference in body height between both group p=0.000 (p <0.05). Such conditions illustrate that G1 have better height than G2. However there was no significant difference in body weight between both groups p=0.053 (p>0.05). The similar opinion was also shown in the study of Hammami et al (2018), trained adolescents are higher and have lean body mass greater than untrained adolescents.

The variable chest circumference showed greater results in G1, but there was no significant difference between both groups p=0.226 (p>0.05). Although the chest circumference in both groups did not have a significant difference, but the vital lung capacity in G1 was greater than G2 with significant differences with a value of p=0,000 (p<0.05). This is possible because in G1 have better contractile strength and respiratory muscle strength. With physical training, there is an increase in oxygen consumption and total pulmonary ventilation increases by about 20 times between resting state and maximum intensity of work conditions in trained athlete (Guyton & Hall 2014). With endurance training, total lung capacity, generally unchanged or perhaps slightly increased, while there is a slight increase in vital capacity and a slight decrease in residual volume (Foss et al 1998).

The variable oxygen saturation (SpO2) showed a significant difference between both groups p=0.001 (p<0.05). Changes in the cardiorespiratory system are caused by exercises that affect the oxygen transport system consisting of blood circulation, breathing and tissue factors. All work together for one purpose, which is to send oxygen when the muscles work (Foss et al 1998). Another physiological response that occurs is an increase in oxygen diffusion capacity several times between the resting state and maximum working conditions. Blood flow through many pulmonary capillaries flows very slowly or even stops at rest. Whereas at maximum work, increased blood flow through the lungs causes all pulmonary capillaries to diffuse maximally, so that a much larger surface area is available where oxygen can diffuse into the pulmonary capillaries. Athletes who need more oxygen per minute have higher diffusion capacity (Guyton & Hall 2014). In the process of metabolism, oxygen is used as an aerobic energy source that is processed in cells. To help the intracellular movement of oxygen from the cell membrane to the mitochondria, myoglobin is needed. Myoglobin amount from skeletal muscle will increase

during aerobic exercise around 75%-80% (Foss et al 1998). This is possible in the group of adolescents trained in oxygen saturation better than the group of untrained adolescents.

The variable HR rest showed a significant differences between both groups p=0,000 (p<0.05). Exercise causes a decrease in resting heart rate called bradycardia (heart rate<60 beats/minute). This is possible because of an increase in heart muscle strength so that stroke volume in trained adolescents is greater. This means that for the same cardiac output, stroke volume in a trained person is greater so that with a smaller heart rate it can meet the body's oxygen needs. Slow heart rate will be more efficient, and the need for oxygen makes the heart beat faster than the same cardiac output. Other factors that contribute to an increase in stroke resting volume in exercise induction can be associated with myocardial contractile. Increased contractility can be associated with increased ATPase activity in the heart muscle and/or strong contractile interactions of cellular elements (because availability of extracellular calcium increases) (Foss et al 1998).

The variable HR exercise showed increased results in response to physical activity. There is an increase in muscle blood flow during physical exercise. Muscle blood flow can increase to a maximum of about 25 times during very heavy work. To meet the energy needs during physical exercise, the body responds with an increase in oxygen demand which is indicated by frequency of HR exercise much higher than at rest. Oxygen consumption and cardiac output also increase during exercise. Due to muscle workload that increases oxygen consumption, further increased in oxygen consumption will dilate the muscle blood vessels, thereby increasing venous return and cardiac output. The effectiveness of the heart pump and each heart rate is 40 to 50 percent greater in highly trained athletes than in untrained people, but there is a decrease in the frequency of heart rate at rest (Guyton & Hall 2014). However, there was no significant difference between both groups p=0.242 (p<0.05). This This is possible because in G1 when measuring MFT, their intensity and endurance are better so they need more energy. With a better work effectiveness of the heart, G1 can do better perform. This is evidenced by the MFT test results much higher in G1. This can be interpreted, with almost the same HR exercise, in trained adolescents have better physical abilities.

The MFT test results showed significant differences in VO2Max between both groups p=0.000 (p<0.05). Trained people with better vital lung capacity and blood circulation, oxygen uptake (VO2) will be greater, that more oxygen sent to the cells. Increased blood volume is the initial adaptive response to exercise. Total blood volume and amount of hemoglobin are increase with endurance training. Both parameters that are important for oxygen transport systems are closely correlated with VO2Max (Foss et al. 1998). Teenagers who have sufficient physical activity, will have a good and maximum endurance. They have a good daily body activity, which makes the endurance (VO2Max) increase in adolescents in the second rapid growth phase.

CONCLUSION

There were significant differences between both groups in body height, vital lung capacity, oxygen saturation, heart rate rest, and VO2Max. Whereas, there were no significant differences between both groups in body weight, chest circumference, and heart rate exercise. Anthropometry and physical abilities of trained individuals was greater than the untrained individuals in the second rapid growth phase (adolescence).

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