

The Effects of Physical Activity and Obesity on Hypertension in Adolescents: Meta-Analysis

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ABSTRACT

Background: The incidence of hypertension is always increasing every year both in Indonesia and in the world. Adolescents with high blood pressure are more likely to become adults with hypertension if not treated immediately. This study aimed to review the effects of physical activity and obesity on hypertension in adolescents using meta-analysis.

Subjects and Method: Meta-analysis was performed by searching for articles from the database, namely Pubmed, Science Direct, Springer Link and Google Scholar. The keywords used are "physical activity" AND "obesity" AND "hypertension" OR "high blood pressure" AND "adolescent" AND "cross sectional". The inclusion criteria in this study were full-text articles with a cross-sectional design, in English, for the period of 2010-2020. Article analysis was using RevMan 5.3.

Results: The total number of articles analyzed was 14 articles from Nigeria, Brazil, Gabon, Germany, Tunisia, Algeria, China, Egypt, Indo-

nesia, Lithuania, Greece, and Ghana. The results of the meta-analysis showed that physical activity increased the incidence of hypertension in adolescents (aOR= 2.70; 95% CI= 1.81 to 4.04; p<0.001; I²= 87%). Obesity increased the incidence of hypertension in adolescents (aOR = 1.71; CI 95% = 1.34 –2.17; p < 0.001; I² = 41%).

Conclusion: Physical activity affects the incidence of hypertension in adolescents. Obesity affects the incidence of hypertension in adolescents.

Keywords: hypertension, physical activity, obesity, adolescents

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Cite this as:

Berek MI, Kristiyanto A, Widyaningsih V (2020). The Effects of Physical Activity and Obesity on Hypertension in Adolescents: Meta-Analysis. *J Health Promote Behav.* 05(04): 296-305. <https://doi.org/10.269-11/thejhp.2020.05.04.07>.



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BACKGROUND

Hypertension, known as high blood pressure, is a global public health problem that contributes to an increasing burden of disease including heart disease, stroke, kidney failure, death and disability (WHO, 2013).

The World Health Organization (WHO) states that hypertension is more common in low and middle income countries, namely 40%, while developed

countries are 35%. Africa is the region with the most hypertension sufferers, which was 46%, America 35% and Southeast Asia 36%. WHO also predicts that by 2025 about 29% of people in the world will experience hypertension (WHO, 2013).

Based on the results of Basic Health Research, the prevalence rate of hypertension in people aged >18 years old in Indonesia has always increased, starting from

2007 at 31.7%, 2013 at 25.8% and in 2018 it increased significantly by 34, 1% (Ministry of Health RI, 2019).

The problem of hypertension in adolescents is an important concern because of the large number of adolescents in Indonesia and in the world. According to WHO, the world's adolescents population is 1.2 billion or 18% of the world's population. In Indonesia, based on the 2010 population census, the number of adolescents is 43.5 million or 18% of the Indonesian population (Data and Information Center of Ministry of Health RI, 2017).

The population projection results show that the number of adolescent age population in Indonesia will continue to increase until 2030 (Demographic Institute of FEB UI, 2017). Based on the results of the study, the prevalence of adolescents aged 11-17 years old suffering from hypertension was 3.2% and the prevalence of prehypertension was 15.7% (Falkner, 2010).

Blood pressure will increase with age and body size, which ranges from 13 to 18 years old. Adolescents with high blood pressure are more likely to become adults with hypertension if not treated immediately (Aglony et al., 2009).

One of the factors that led to an increase in the prevalence of hypertension among adolescents was the lack of physical activity carried out by adolescents. Nowadays, adolescents more often spend their time playing gadgets, watching TV and tutoring so that they take longer to sit and be driven or picked up by private or public vehicles rather than choosing to walk or bike (Batara et al., 2016).

Physical activity has been shown to have an effect on blood pressure. Research conducted by Amra et al. (2020) states that individuals with insufficient physical activity are 2.86 times more likely to suffer

from hypertension than individuals with sufficient physical activity.

Hypertension is also a comorbidity that is most often found in adolescents with overweight (obesity) (Kelly et al., 2015). The increasing prevalence of obesity is also followed by an increase in the prevalence of comorbidities, including an increase in blood pressure (Indonesian Pediatric Association, 2014).

There is a strong relationship between hypertension and obesity in adolescents, indicating that the prevalence of hypertension in adolescents will increase (Flynn & Falkner, 2011). Research by Arum (2019) states that obese adolescents were 2.51 times more likely to develop hypertension than adolescents with normal weight.

Yusrizal et al. (2016) and Amra et al. (2020) stated that obese individuals have a 2.44 times greater risk of suffering from hyperemia compared to those who are not obese.

Based on the results of various primary studies that show the influence between physical activity and obesity on the incidence of adolescent hypertension, it encourages researchers to conduct systematic review and meta-analysis study to combine and analyze several study results that have been carried out then draw conclusions about the effect of physical activity and obesity on the incidence of hypertension among adolescents.

SUBJECTS AND METHOD

1. Study Design

This study used meta-analysis and systematic review, the articles analyzed were searched in the PubMed, Google Scholar, Science Direct and Springer Link databases.

2. Inclusion Criteria

The inclusion criteria in this study were full text articles with cross-sectional study

design, articles were in English, articles with multivariate analysis.

3. Exclusion Criteria

The exclusion criteria in this study were published articles and meta-analysis articles.

4. Operational Definition

Physical activity: movement activities that require or expend energy or planned body movements that involve repetitive body movements with the aim of increasing energy.

Obesity: accumulation of fat in the body that exceeds the need for normal body function by measuring Body Mass Index \geq 95th percentile.

Hypertension: a condition characterized by increased blood pressure in adolescents \geq 95th percentile.

5. Data Analysis

Data analysis in this study using RevMan 5.3 and analysis included in this study with fixed effect and random effects analysis.

RESULTS

The research articles used were searched and selected from several databases, namely PubMed, Science Direct, Springer Link and Go

ogle Scholar. The keywords used for article searches are “Hypertension OR High blood pressure AND Physical activity AND Adolescent”, “Hypertension OR High blood pressure AND obesity AND adolescent”, “Hypertension OR High blood pressure OR Physical activity OR obesity OR adolescent OR Cross sectional”. The process of searching for articles can be seen in the search flow as follows:

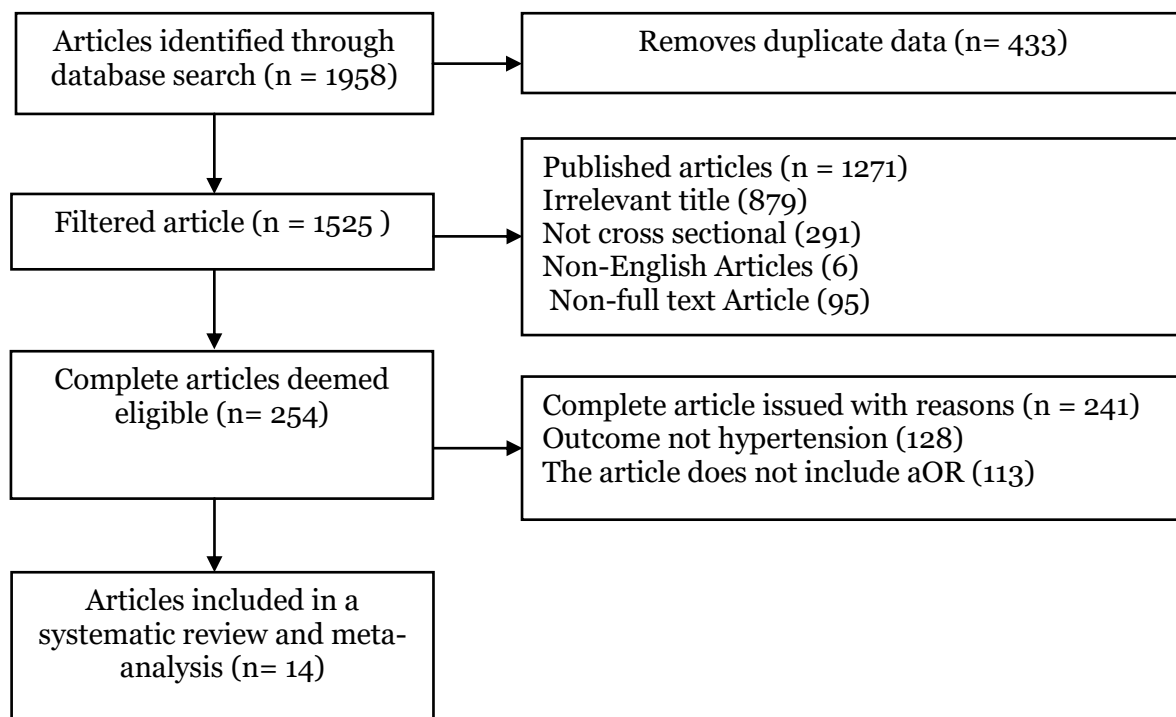


Figure 1. PRISMA diagram flow

The initial search process obtained 1.958 articles, then the process of deleting duplicated articles was carried out, it

obtained 1,525 articles including 254 complete articles and fulfilling the requirements, then a full text article search was

carried out. Complete articles that were included in the inclusion criteria because of the following reasons:

1. Not using a cross sectional study design
2. Outcome is not hypertension
3. Does not include the aOR value

Research on the effect of physical activity and obesity on the incidence of hypertension in adolescents consists of 14

articles from 4 continents, namely Africa, America, Europe and Asia.

The articles identified and obtained 14 observational articles with cross-sectional study designs were eligible as sources of impact meta-analysis

Physical activity and obesity on the incidence of hypertension in adolescents can be seen in tables 1 and 2 below:

Table 1. The Effect of Physical Activity on the Incidence of Hypertension in Adolescents

Author (Year)	Country	Sample	aOR	95% CI
Omisore et al. (2018)	Nigeria	1,000	1.53	0.80 to 2.93
Sarganas et al. (2018)	German	2,542	1.75	0.69 to 4.44
Silva et al. (2016)	Brazil	875	2.20	1.00 to 4.84
Skhiri et al. (2012)	Tunisia	2,870	4.20	1.80 to 9.80
Sudiasih et al. (2019)	Indonesia	203	5.87	1.19 to 28.96
Zhang et al. (2019)	Ghana	1,161	1.42	1.04 to 1.94

Table 2. The Effect of Obesity on the Incidence of Hypertension in Adolescents

Author (Year)	Country	Sample	aOR	95% CI
Abolfotouh et al. (2011)	Egypt	1,500	2.18	1.38 to 3.44
Benmohammed et al. (2011)	Algeria	305	1.90	1.10 to 3.28
Bivigouet et al. (2020)	Gabon	613	1.56	0.30 to 8.11
Christofaro et al. (2017)	Brazil	1,231	1.04	0.63 to 1.72
Dulskiene et al. (2014)	Lithuania	7,457	6.64	4.65 to 9.48
Leunget et al. (2014)	China	6,193	1.43	0.99 to 2.07
Manios et al. (2019)	Greece	1,444	2.61	1.88 to 3.62
Omisore et al. (2018)	Nigeria	1,000	12.43	4.63 to 33.37
Sarganas et al. (2018)	German	2,542	2.70	1.78 to 4.10
Zou et al. (2019)	China	2,639	4.02	2.82 to 5.73

a. Forest Plot of Physical Activity and Adolescent Hypertension

Interpretation of the results of the meta-analysis process on the effect of physical

activity on the incidence of hypertension in adolescents can be seen through a forest plot:

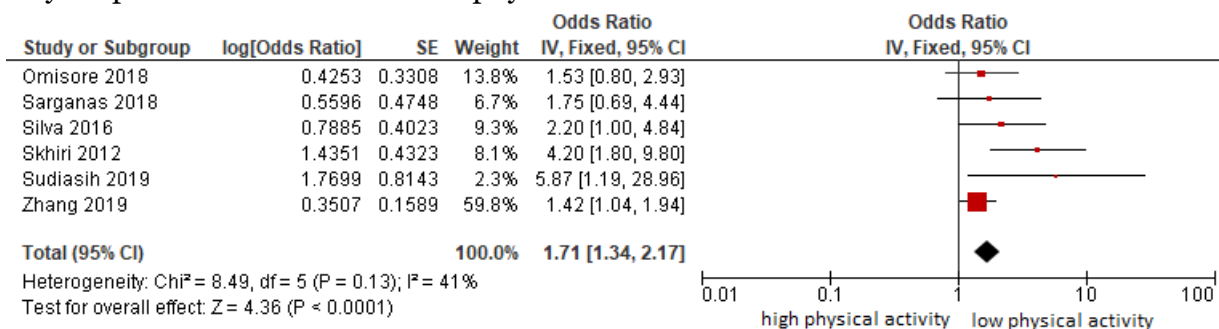


Figure 2. Forest Plot of the Effect of Physical Activity on the Incidence of Hypertension in Adolescents

Figure 2 shows that adolescents who do low physical activity were 1.71 times increased the risk of hypertension compared to adolescents who do moderate/high physical activity (aOR= 1.71; 95% CI= 1.34 -

2.17) with values ($p < 0.01$). The heterogeneity of the study data showed $I^2 = 41\%$, then the data distribution was not heterogeneous (homogeneous) so that it used a fixed effect model.

b. Funnel plot of Physical Activity and Adolescent Hypertension

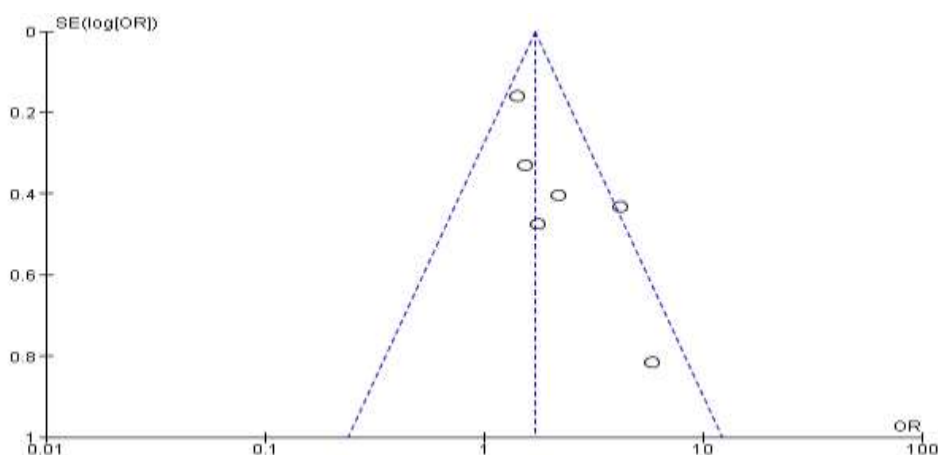


Figure 3. Funnel Plot of the Effect of Physical Activity on the Incidence of Hypertension in Adolescents

Figure 3 showed the publication bias which was characterized by asymmetry between the right and left plots where there are 2 plots on the left and 4 plots on the right. The plots on the left of the graph have a standard error between 0 and 0.2 and all plots on the right have a standard error between 0.4 and 0.8.

c. Forest Plot of Obesity and Hypertension in Adolescents

Interpretation of the results of the meta-analysis process on the effect of obesity on the incidence of hypertension in adolescents can be seen through a forest plot.

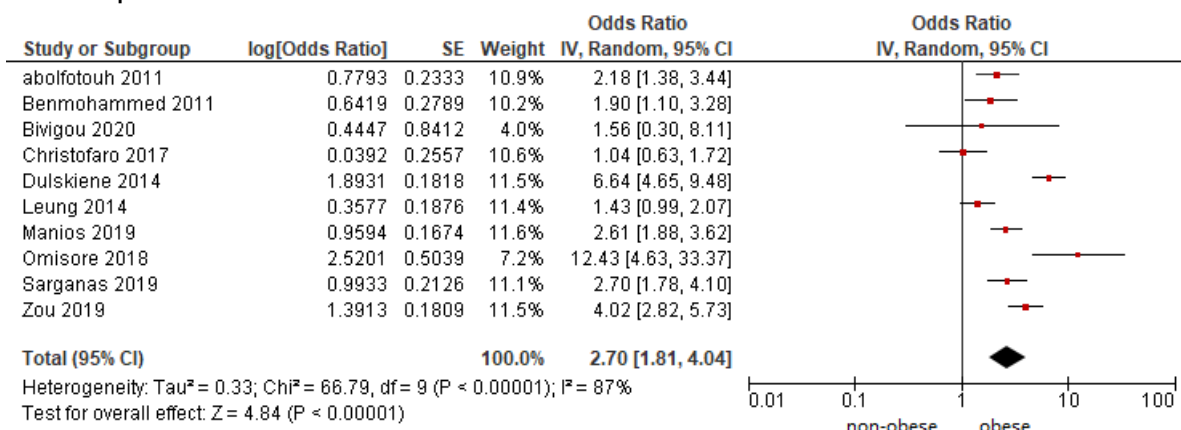


Figure 4. Forest Plot of the Effect of Obesity on the Incidence of Hypertension in Adolescents

Figure 4 showed that adolescents with obesity were 2.70 times increased risk of

hypertension compared to adolescents who were not obese (aOR= 2.70; 95% CI= 1.81 -

4.04; $p < 0.01$). The heterogeneity showed $I^2 = 87\%$, so the data distribution was heterogeneous (random effect model).

d. Funnel Plot

Figure 5 showed the publication bias which is characterized by asymmetry between the

right and left plots where there are 7 plots on the left and 3 plots on the right. The plots on the left of the graph have a standard error between 0 and 0.8 and all plots on the right have a standard error between 0 and 0.4.

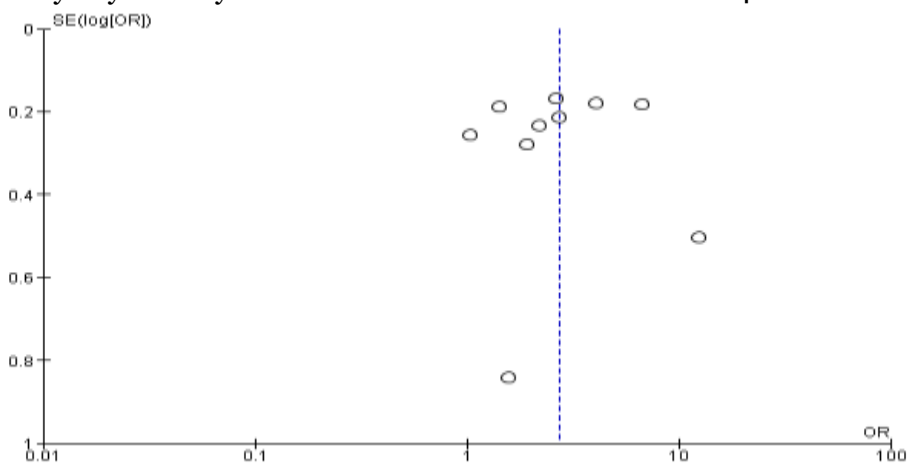


Figure 5. Funnel Plot of the Effect of Obesity on the Incidence of Hypertension in Adolescents

DISCUSSION

This systematic review and meta-analysis study has the theme of the effect of physical activity and obesity on the incidence of hypertension in adolescents. Study on hypertension in adolescents is considered important because the number of relevant studies that can be accessed is still limited and has data duplication problems (Murti, 2018).

Most studies only report the total percent or crude odd ratio (cOR) so that they cannot control for confounding factors. Confounding factors affect the relationship or effect of exposure to the disease, which may be different from the relationship or exposure that should occur in the population which caused invalid study result (Murti, 2018).

This systematic review and meta-analysis study used studies that controls confounding factors as seen from the inclusion criteria set, namely multivariate

analysis so that the final result is the adjusted Odd Ratio (aOR) value.

Estimated results of study on the effect of physical activity and obesity on the incidence of adolescent hypertension, the data were processed by using the RevMan 5.3 application using the generic inverse-variance method.

The results of this systematic review and meta-analysis study are presented in the form of a forest plot and a funnel plot. Forest plot is a diagram that presents overall information from each study result used in this study by showing the level of variation visually (heterogeneity) (Akobeng, 2005 in Murti, 2018). The funnel plot is a diagram that shows the possibility of publication bias by showing the relationship between the effect size of the study and the sample size or standard error (Murti, 2018).

1. Physical Activity and Hypertension

The results of the forest plot show that adolescents who do low physical activity

were 1.71 times more likely to have an increased risk of hypertension compared to adolescents who do moderate/high physical activity.

The results of this study are in line with research conducted by Wyszynska et al, (2017) on adolescents in Poland, which proved that adolescents with low levels of physical activity were 4.40 times higher in increasing the risk of hypertension than adolescents who did high physical activity.

Another study conducted by Barros et al. (2013) in Brazil on 3.764 adolescents showed that 66% of adolescents reported being physically inactive with a prevalence of high blood pressure of 14.6%. Based on the odds ratio value, inactive adolescents have high blood pressure of 1.24 which mean that adolescents who do not do physical activity are 1.24 times more likely to increase the risk of hypertension.

2. Obesity and Hypertension

The results of the forest plot show that obese adolescents were 2.70 times more likely to have hypertension than adolescents who were not obese.

The results of this study are in line with a study conducted in the United States by Ford, Nonnemaker, & Wirth, (2008) which showed that obese adolescents tend to have high blood pressure than adolescents with normal weight or have higher risk of hypertension by 1.96 times .

Obese adolescents have a higher risk of suffering from cardiovascular diseases including hypertension, where an increase in body mass index will increase the risk of hypertension. Obese adolescents are at risk by 2.5 to 7.6 times greater than adolescents who are not obese (Committee on Adolescent Health Care, 2017).

Stiefel et al (2016) conducted on student athletes in Mississippi, United States showed that obese student athletes were 2.40 times more likely to have blood

pressure than student athletes who were not obese and the relationship between obesity and hypertension was statistically significant ($p < 0.001$).

A limitation of this study is the possible publication bias shown in the funnel plot of the effect of physical activity and hypertension. Language bias occurs because this study only uses research articles published in English and does not use research articles in other languages. Search bias occurs because researchers only use 4 databases (PubMed, Science Direct, Springer Link and Google Scholar) to search for articles so that the researchers do not search other databases.

AUTHOR CONTRIBUTION

Maria Imakulata Berek, Agus Kristiyanto, and Vitri Widyaningsih, collected and selected the articles, examine critical judgement for each article, did qualitative synthesis, and did quantitative synthesis for meta analysis.

CONFLICT OF INTEREST

We declare that there is no conflict of interest.

FUNDING AND SPONSORSHIP

This study did not use any funding and sponsorship due to the secondary data and the databases that could be easily accessed. It also provided open access journals.

ACKNOWLEDGEMENT

We thank to authors and online journal databases that provide research related with this study.

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