ISSN 2620-8423 (print) | 2620-5653 (online)

The status of body mass index on heart rate recovery in young adults: literature review

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ARTICLE INFO

Article history
Received, 27-th July 2021
Revised, 26-th March 2022
Accepted, 21-st April 2022

Keywords
Body Mass Index
Heart Rate Recovery
Young Adults

ABSTRACT

The development of modern adaptation increases the prevalence of obesity with a characteristic of fat hoarding especially in young adults. Young adults are the most common users of gadgets, and they have sedentary lifestyle. Body Mass index (BMI) is the ratio of weight in kilogram (kg) and height that has been squared in meter (m) and becomes the easiest parameter to measure excess fat. Excessive fat accumulation can affect vagal reflex, causing an impact in Heart Rate Recovery (HRR). Delayed HRR or ≤ 12 bpm increases the risk of arrhythmia and sudden cardiac death. The purpose of this review is to determine the status of BMI on HRR in young adults. The searching for article reviews used electronic database with several databases namely PubMed, Ebscohost, Proquest, and Google scholar resulted nine eligible articles. Overweight decreased HRR and delaying vagal reactivation which increased the risk of death caused by sympathetic nerve dominance which increased the risk of heart attack. Based on the review result, the profile of anthropometry can describe the fitness status of the cardiovascular system.

1. Introduction

According to World Health Organization (WHO) (World Health Organization, 2015), there was a significant increase in obesity case which was, in 2015, more than 1.9 billion young adults (65%) over 18 years old were overweight. Human population in different parts of the world were rapidly overweight and obese. According to Popkin et al. (2012) obesity rate in the South Asia region have increased by threefold over the last 20 years caused by the development of the region into an urban with a sedentary lifestyle and high caloric intake. People want the ease in doing daily activities like eating fast and instant food to save time such as fast food and junk food. The result of Indonesian Basic Health Research in 2018 was the number of people in Indonesia aged ≥ 18 years who were obese from 2007 to 2018 increased from 10.5% to 21.8%. Obesity is closely related to excess fat.

Parameter for measuring excess fat is by anthropometric measurement to find out the nutritional status independently consisting of height, weight, Body Mass Index (BMI), Waist Circumference (WC), waist-to-hip-ratio (WHR), and Sum of Skinfold Thickness (SUMFT) to assess the body composition of. These measurements play an important role in accurately categorizing obesity. Body Mass Index (BMI) is one of the most common methods of anthropometric measurement by comparing weight in kilogram (kg) with height that has been squared with meter (m).

The high accumulation of fat in the body causes the thickening of the walls of blood vessels so that the blood flow space narrows. Then, there is a decrease in the amount of blood pumped making the decrease of the circulation of oxygen to the muscles. The narrowing of blood vessels also results in

thickening of the ventricles caused by heavier work of the heart to channel blood to the entire parts of the body. One of the things that can be used to predict the heart wellbeing is using the Heart Rate.

When doing an activity, the autonomic nervous system has a role in cardiovascular function to fulfill the metabolic needs of the body. Sympathetic nerve stimulation increases the heart rate (HR) during the activity, while the parasympathetic nervous system serves to lower HR. The high amount of fat in the body can inhibit heart function when doing physical exercises. When physical exercise activity takes place, the muscles that are actively working will fail to perform oxygen extraction caused by fat imbalances in the body. It affects the time it takes for the heart to recover its heart rate taking longer time. So, the recovery of heart rate after activity towards the rest phase is called as Heart Rate Recovery (HRR) value. HRR value below normal limit can be used as an early prognosis of Cardiovascular Disease (CVD). Heart Rate Recovery (HRR) is a person's ability to restore heart rate after performing physical exercise by describing the balance of the autonomic system between the reaction of the sympathetic and parasympathetic systems. The faster the heart rate returns to the initial phase before physical activity, the better a person's HRR status will be. Meanwhile, HRR value below normal limit can be used as an early prognosis of Cardiovascular Disease (CVD). Based on the reasons aforementioned, it is necessary to carry out a review related to the status of anthropometry of HRR in young adulthood for early detection of cardiovascular disease.

2. Methods

The method of the article search used several electronic databases such as PubMed, Ebscohost, Google Scholar, and ProQuest. Then, the search for article journal used several specific keywords by adding the two quotations above before the keywords used and by adding conjunction words like AND and OR. The keywords, used with AND conjunction, were 'body mass index' AND 'heart rate recovery' AND 'young adult'. Meanwhile, OR conjunction was used to connect synonyms such as 'young adult' OR 'adolescents' OR 'college student'. The use of conjunctions aims at facilitating the search for journals which were specific and in accordance with the literature review compiled. Electronic searches were conducted manually using articles published from 2010-2020. The articles taken were articles that used experimental, comparison and correlation methods related to the influence of BMI on HRR in data collection method. In addition, the respondents in the study were the healthy ones. Whenever there were respondents who had cardiovascular disease history, then the article would be excluded.

The process of completing the article was arranged in accordance with the prism diagram in Fig. 1. Initial search using the keywords resulted in 820 articles showing high relevance to the topic. The researcher then added the use of article limitations on each database between 2010-2020 so that 532 articles were obtained. After additional searches in the form of duplication and screening of titles and abstracts, 183 articles were obtained and then included in the next stage namely full text study in accordance with inclusion and exclusion criteria that have been determined by the researcher. The eliminated articles were the ones with respondents of people who were not normal with Cardiovascular Disease (CVD) history. There were nine articles that have covered all requirements of the research and their qualities were reviewed. Then, they were synthesized using double screening method.

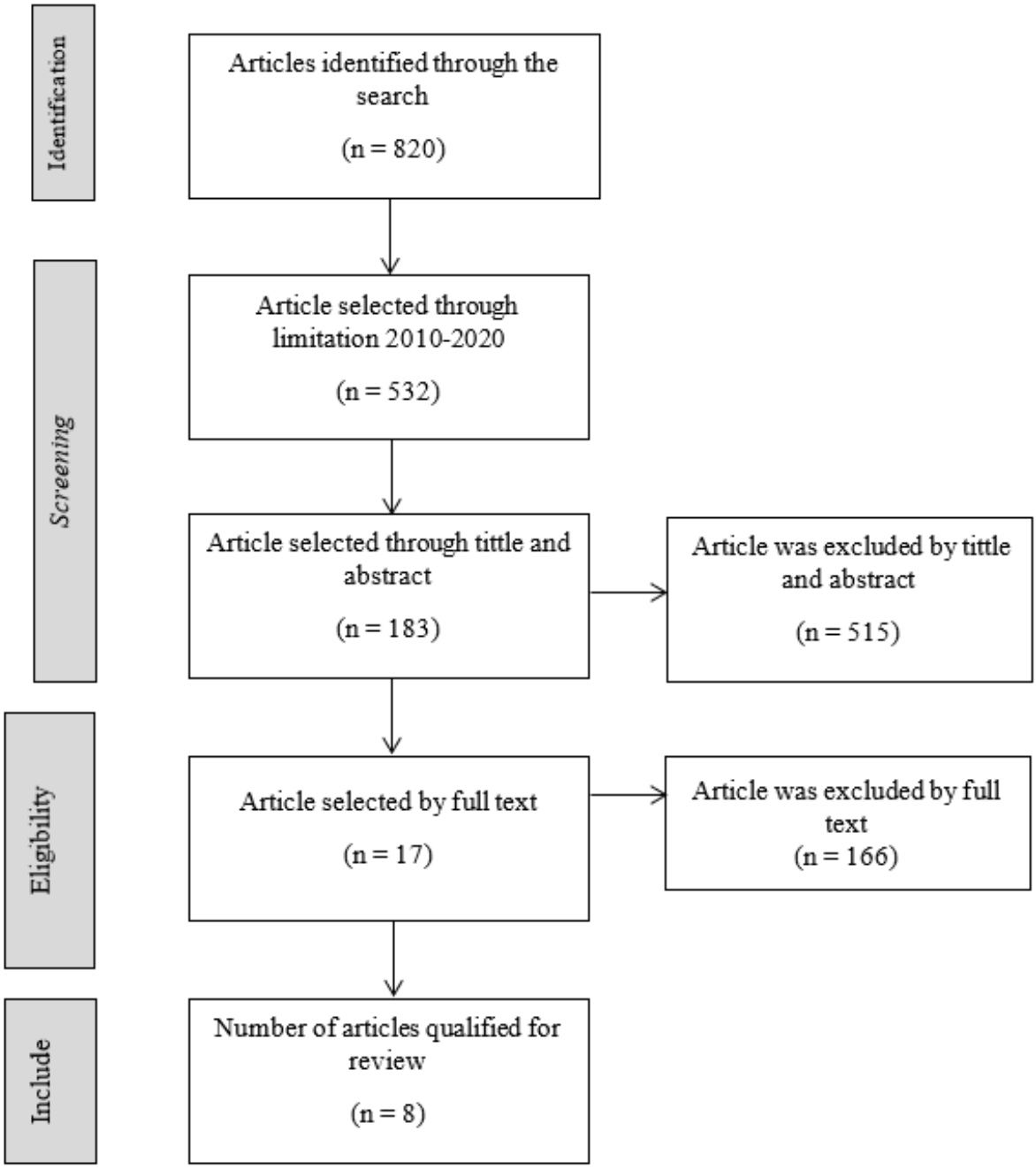

Fig. 1. Prisma Diagram

3. Results

Table 1. Journal Characteristic Study

No	Researcher/ year	Study Design	Setting	Participant	Variable	Result	Database
1	(de Araújo et al., 2017)	Quantitative survey	Federal University of Mato Grosso, Brazil	The healthy 29 males between 18-25 years old divide into BMI category were 9 in normal weight, nine overweight and eleven obese.	BMI and HRR	There were no differences between HRR and BMI, however aerobic fitness influenced HRR	ProQuest
2	(Dimkpa & Oji, 2010b)	Quantitative, correlation	Students and members of staff of Igbinedion University, Okada, and residents of Okada town in Edo State, Nigeria.	The healthy adults 325 with aged 18–66 years	BMI, Blood Pressure, Exercise Test, HRR	There is relationship between BMI and HRR	Google Scholar
3	(Carnethon et al., 2012)	Longitudinal Cohort	The Coronary Artery Risk Development in Young Adults (CARDIA), Birmingham, Chicago, Minneapolis, Oakland	5115 adults with aged 18-30 year at baseline (1985-1986). Participants were reexamined 2,5,7,10,15 and 20 years after baseline.	BMI, Physical activity, HRR	The higher BMI have associated with slow HRR	Google Scholar
4	(Jezdimirovic et al., 2017b)	Quantitative study	Espanyol	The healthy children and adolescents (n=255)	BFP, HRR	A strong positive correlation between BFP and HRR	ProQuest
5	(El Agaty et al., 2017)	Quantitative study	Laboratory if Physiology, Faculty of Medicine, King Abdul Aziz University	Fifty-five female students were classified into normal and overweight	HRR, Overweight/obese healthy female	HRR increased in overweight/obese female students	PubMed
6	(Lins et al., 2015)	Cross-sectional study	Clinic specialist in Recife, Brazil	Both male and female 2443 patients, aged between 20 and 59 years, sinus rhythm, not using negative chronotropic agent,	HRR after exercise, BMI	Higher BMI demonstrating impaired HRR	PubMed
7	(Sco et al., 2011a)	Experimental	-	The healthy of fifty adult young men with age (21.9±3) years old, height (180.8±7.2) cm, weight (80.4±9.1) kg. Before testing the participant not allowed to consumed caffeine for 12 hours and alcohol for 24 hours.	Skinfold thickness, HRR1, HRR2, HRV	Skinfold thickness correlated with HRR1	Google Scholar

8	(Hanifah et al., 2013)	Prospective longitudinal cohort study	The Malaysian Health and Adolescents Longitudinal Research Team (My HEART) in the northern and central zone of Malaysia-Perak, Selangor, and Kuala Lumpur	Both genders whose boarding in school with age 13-17 years old.	Body Compositi on (BMI, Body Fat, WHtR)	BMI not correlated with HRR, however Body fat correlated with HRR2	ProQuest

BMI: Body Mass Index; HRR: Heart Rate Recovery; WC: Waist Circumference; BFP: Body Fat Percentage.; HRV: Heart Rate Recovery; WhtR: Waist height ratio.

4. Discussion

The presentation of the journal analysis results state that Heart Rate Recovery (HRR) can be influenced by the Body Mass Index (BMI) in which HRR serves to describe the risk of cardiovascular disease. Anthropometry measurement plays an important role in identifying obesity as *a screening* of cardiovascular disease. Anthropometry has various types of measurements, one of which is BMI. BMI does not directly measure the percentage of body fat, but it has proven that there is a correlation between body weight and body fat (World Health Organization, 2015). BMI measurement is a good parameter for weight classification, especially obesity because BMI is quite similar to the picture of fat distribution in adults which is mostly stored as visceral fat (Sakurai et al., 2016). When correlated with HRR (Dimkpa & Oji, 2010a) and (El Agaty et al., 2017) mention that BMI becomes the best parameter used to discover the impact of body fat on HRR but not with mentioned that aerobic fitness has a strong correlation to HRR despite BMI index in young men.

Visceral fat is fat with active tissue located in the abdominal cavity which also mentioned in (Sco et al., 2011b) and (World Health Organisation, 2015). Beside the hoarding in the abdominal area, visceral fat is also very active in producing several hormones such as *Interleukin-6* (IL-6), *Interleukin-1 beta* (IL-1β), *Plasminogen Activator Inhibitor-1* (PAI-1), and *Tumor Necrosis Factor Alpha* (TNF-α). The existence of the hormones indicate that the body has inflammation and it can trigger inflammation so that the risk of chronic diseases such as coronary heart increases (Makki et al., 2013). Tumor Necrosis Factor Alpha (TNF-α) is powerful cytokine or anti-inflammatory mediator of proinflammatory, mainly secreted from myeloid cells through the activation of mitogen activated protein kinase (MAPK) signaling pathways and Nuclear Factor *Kappa Beta* (NF κ B) and resulting in the release of other inflammatory cytokines, such as IL-1 β and IL-6. The level of TNF- α is higher in plasma and adipose tissue in obese individuals, but TNF - α will be reduced if there is weight loss. TNF-α also indirectly induces insulin and lipolysis resistance as well as secretion of free fatty acid that cause increased glucose production in liver.

In addition, chronic inflammation in adipose tissue has an impact on the deviation disruption of excess nutrient reserve as triglycerides can cause hyperlipidemia. Hyperlipidemia refers to an increase in cholesterol, and an increase in triglycerides or both (Nelson et al., 2019). The hoarding of fat in the form of triglycerides and residual fat of excess nutrient in the blood can cause the inner artery walls to thicken or harden and it is called atherosclerosis (Lusis, 2012). The hoarding process starts from endothelial cell damage of coronary blood vessels because most of the cholesterol will slowly accumulate under the endothelium in the entire arteries of the body (Guyton & Hall, 2006b). Gradually, the area that undergoes cholesterol hoarding is invaded by fibrous tissue and is often calcified. The result of the process is the formation of atherosclerotic plaques that protrude into the lumen of blood vessels and inhibit all or part of the blood flow. This will result in clogged arteries making it difficult for the heart to contract because the oxygen supply that is supposed to flow to the heart becomes reduced. If this is not immediately known, it can cause the heart muscle to decay or necrosis (Guyton & Hall, 2006a). Disruption of endothelial cells affected by visceral fat will further affect the contraction of the heart muscle. The one of the effects of high BMI is influenced the HRR

based on (Barbosa Lins et al., 2015; Carnethon et al., 2012; Dimkpa & Oji, 2010b; El Agaty et al., 2017; Jezdimirovic et al., 2017a).

The mechanism of weight gain can affect the autonomic nervous system, namely lowering the activation of the parasympathetic system and increasing the hyperactivity of the sympathetic nervous system. This is due to the hormones released by visceral fat so that the sympathetic nervous system becomes more reactive. Hyperactivity of the sympathetic nervous system in a person indicates that the person has a higher risk of morbidity and mortality. The autonomic nervous system is a system that regulates organs in the body, one of which is the cardiovascular system. Stimulation on the autonomic nervous system will increase activation or decrease activation of the cardiovascular system in the form of increased or decreased heart rate. So, the sympathetic nervous system plays a role in increasing heart rate and the parasympathetic one plays a role in lowering the heart rate. HRR is a condition of parasympathetic nerve reactivity and decreased sympathetic nerve work. The combination of autonomic nerve hyperactivity and endothelial cell disorder caused by fat hoarding will affect the delay of HRR.

Physiologically, when a person is doing activities or sports, there will be an increase in Heart Rate due to the activation by sympathetic nerves in order to meet the needs of tissue oxygenation. On the contrary, after resting, the reactivation of the parasympathetic nervous system starts, with decreased heart rate. The result of late HRR measurement or $\leq$ 12 bpm has prognostic value in predicting ventricular arrhythmia and sudden cardiac death. Based on this, BMI can be used as the initial basis for screening the risk of cardiovascular system health status through HRR.

5. Conclusion

Heart Rate Recovery (HRR) measurement is a picture of cardiovascular fitness that can be measured in every person. A person with a BMI measurement that exceeds normal limit and has a habitual lifestyle of lack of movement or exercise can increase the risk of cardiovascular disease with decreased HRR.

Acknowledgment

The author would like to thanks to Universitas Muhammadiyah Yogyakarta for the research funding with the number decree 550/PEN-LP3M /II/2020.

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