Sport and Fitness Journal
E-ISSN: 2654-9182 Volume 10, No.1, January 2022: 60-68

GENERAL PERSPECTIVE OF CYCLING IN CARDIOVASCULAR HEALTH ASSOCIATED WITH AGING PROCESS

Rynda[1], Vidya M. Dewi Tanaka[1], Inaroh Qudsiyah[1], Ni Ketut Ayu Maharani[1], Demak Vera Rachelia[1], Nadia Carolina Notoprawiro[1], Kenny Augusto[1], Made Ayu Mirah Wulandari[1], Indira Vidiari Juhanna[2],
[1] Anti-Aging Medicine Post Graduate Program Biomedic Medical Faculty Universitas Udayana, 80234, Denpasar, Indonesia
[2] Physiology Department Medical Faculty Universitas Udayana, 80234, Denpasar, Indonesia
Email: rynda.prasetya@gmail.com

ABSTRACT

Background and Objectives: One of the most causes of death in the world is cardiovascular disease (CVDs). Being physical active is known to be able to reduce cardiovascular risk. For many people, cycling is a very common sport recreation activity. It is one of the physical activities that could helps improve cardiovascular function, and cycling is an aerobic process that causes the heart, blood vessels, and lungs to exercise. Cycling is categorized as a cardio workout because it will optimize the productivity of the heart, lungs, and blood circulation system. This review will analyze the cardiac changes associated with the aging process that causes CVDs and to illustrate the advantage of optimum cycling in maintaining cardiovascular health.

Methods: Data were collected from some literature that containing key words of cycling, cardiovascular health, and cardiovascular aging. The criteria of article were clinical trial, observational trial and review study from 10 years latest. From 332 studies and review, 32 were included.

Results: Cycling might decrease cardiovascular disease risk factor, and aging process. Such results may be accomplished as a stand-alone intervention or in combination with other physical or dietary activities.

Conclusion: In terms to boost cardiovascular health, slow down the aging process, cycling and dieting are advised. These results should be taken with caution, considering the lack of randomized controlled trials, and there is no meta – analysis data associations cycling and cardiovascular disease risk factor.

Keywords: cardiac aging; cycling; stress

INTRODUCTION

Cardiovascular diseases (CVDs) has become a burden for many developing countries, such as Indonesia. This is also the primary source of cases of morbidity and mortality. In Indonesia, 1 from 3 deaths are caused by CVDs and this is also the main source of morbidity and mortality [1] .The cross-sectional study in Indonesia shown that 30% of older adults are at risk for CVDs. Some vascular risk factor for these diseases are preventable, particularly obesity, hypertension, diabetic and active tobacco use [1,2]. The impact of cardiovascular diseases to the heart and blood vessel including hypertrophy, heart fibrosis, heart failure, arrythmia, atherosclerosis and lead to myocardial infarction, stroke and cardiac arrest [3,4]. Therefore, it is necessary to take precaution action at early phase, so community will be aware on the risk of CVDs and maintain their healthy lifestyle.

WHO recommends at least doing physical activities and/or exercise with moderate intensity for 150 minutes per week [2]. Recent research shows that increasing physical activity has health impact, both for physical and psychological, so that physical activity can be used as a new habit in society. One of common and wellknown activity, cycling, have beneficial impact on the function of cardiorespiratory system and metabolism throughout the body at various intensities [5].

It has the intensity to effectively train cardiorespiration and body metabolism, thus providing a number of health benefits [5]. Cycling associated with a decreased risk factor of CVD in adults. Daily walks or cycling as well as commuting are inversely linked to profile lipid serum in a large sample of Chinese adults, include total serum cholesterol, triglycerides and low-density lipoprotein levels among men, and can improve high-density lipoprotein cholesterol levels among women compared to persons travelling by bus [5].

A study shown that children cycling to school have a lower risk of cardiorespiratory disease and greater health than passive commuters and pedestrians. The correlation between commuting to school using a fitness-based and aerobic bicycle was found to be 5 percent better for 9-year-old girls who rode a bicycle and 7 percent better for boys. In comparison, 15-year-old girls who cycled had 11% greater health than passive travelers, and boys cycled 7% better than pedestrians [5].

Cycling is categorized as a cardio workout because it will optimize the productivity of the heart, lungs, and blood circulation system. The greater performance of the circulatory or cardiovascular system will lower the risk of stroke, heart attack, and high blood pressure [2].

Therefore, this article is aimed to review the cardiac changes related with aging process that cause CVDs and shown the overall benefit of cycling to maintain cardiovascular health.

METHODS

In this review article, we searched and collected many literatures from three electronic database, Biomed Central, Scopus and Pubmed. We examined those literatures that had correlation between cycling and cardiovascular health by terms “Cycling and Cardiovascular health and Cardiac aging”. Those literatures were combined for each of three electronic database system. All published and reviewed articles from data base only in English language and had rating Q1-Q2.

Based on article titles, the identified reports were initially evaluated for inclusion and exclusion criteria, which is inclusion criteria as follows: clinical trial, observational study and review study, publication date: 10 years latest, subjects: no gender limits, >65 years old, measures of health and function (e.g fitness).

Whereas exclusion criteria that we used are articles not focused on cycling specifically, not in term of sport medicine, not related with cardiovascular aging. The raw data we found 332 hits then became 32 hits after we selected them by inclusion and exclusion criteria.

DISCUSSION

Sedentary lifestyle, marked by chronically low levels of physical activity, are now recognized as the leading contributors to poor cardiovascular health among the many risk factors that predispose to CVD development and progression. Being inactive in combination with unhealthy diet will lead to one of the cardiovascular risk factors which is excessive body weight, ended with obesity [3,4]. That condition associated with metabolic syndrome, such an impaired response of the body to insulin, persistent inflammation, and formation of ectopic fat (including cardiac deposit of ectopic fat). These factors contribute to cardiac metabolic pressure and increased amount of myocardial work and interfere with the body’s hemodynamic processes [7] .The increasing rate of fatty acid uptake and utilization, also decreasing of glucose oxidation, will impact cardiac metabolism, and decreasing insulin sensitivity rate. The condition will lead to intramyocardial lipid accumulation, results in “lipotoxicity”, the amassment of lipids and its metabolites, which impact the function of cardiovascular system [7].Cycling as physical activity, is known as a cardio exercise to help promotes cardiovascular function and optimizes the performance of cardiorespiratory system and blood circulation. The heart muscle that is trained regularly would work optimal to deliver blood and oxygen throughout the body. Higher circulatory or cardiovascular system output can reduce the risk of stroke, heart attack, and high blood pressure [7].

Below detail explanation about cycling to maintain cardiovascular health and prevent the aging process to the cardiac function.

AGING PROCESS IN CARDIAC STRUCTURE AND FUNCTION

Aging has several impacts in many organs, including cardiovascular. Senescence of cardiovascular impairs many functional pathways and leads to dysfunction and diseases. By age, hypertrophy left ventricle and aorta stiffness are usually happened. Aorta stiffness is related with accumulation of collagen and depletion of elastin. Collagen accumulates in the aorta due to activation of transforming growth factor (TGF**β**). Meanwhile, depletion of elastin is caused by activity of matrix metalloproteinase (MMPs) and inflammatory process that also contributes [9]. If aorta begins to stiff then it can lead to deceleration of blood flow and brings hypoxemia. When this condition be chronic, it can lead to deceleration of ventricular filling and significant atrial enlargement, and finally causes diastolic dysfunction. This condition increases resistance left ventricle filling and has a potency to be one situation, called heart failure [10]. By aging, systolic function is also impaired. Left ventricular ejection is precursor of left ventricle systolic performance. With myocardial stiffening, decrease its contractility, related to deterioration of maximum heart rate and maximum ejection fraction during exercise, happened concomitantly. All of these render cardiovascular diseases.

Mostly, left ventricle hypertrophy is happened in cardiac aging. Left ventricle hypertrophy due to a rise of cardiomyocyte capacity, fibrosis, and asymmetric development of the interventricular septum, not by total cardiac mass [11]. Hypertrophy in left ventricle and interventricular septum may ultimately lead to the myocardial fibrosis, irregular heartbeat, advanced myocardial decadency and end-stage heart failure[10].

Beside hypertrophy left ventricle and aorta stiffness, endothelial dysfunction also has major role in cardiac aging. Endothelium are the cells that compose the lumen of blood vessels. With aging, blood vessels become hard to dilate and oxidative stress aggravates it, rendering atherosclerosis and finally favoring cardiovascular diseases. The reduction of bioavailability of nitric oxide (NO) provides endothelial dysfunction. This reduction can occur due to depletion of NO synthesis and degradation of NO. In the physiological condition, endothelial nitric oxide synthase (eNOS) produces NO from L-arginine. By age, eNOS has alterated function and impair synthesis of NO [9]. Meanwhile, degradation of NO due to increasing reactive oxygen species (ROS). Study from Tocchi *et.al* [12]. describes a general decline in mitochondrial capacity and increases production of Reactive Oxygen Species (ROS). That deterioration suppresses the autophagy process[12]. renders structural and functional impairment. It is because reduction of autophagy process can affect the capacity of recycling and degradation of intracellular components[13]. Along with increasing "waste" in intracellular and production of ROS, mitochondria is particularly susceptible to oxidation. It leads to several effects: necrosis, apoptosis, inflammation, and immunological dysfunction[14].

The permanent Ca^{2+} in cardiomyocyte have negative effect on ROS production. In elderly, reuptake rate Ca^{2+} relate to down regulation of SERCA 2 protein that make prolonged sistol and diastole and make maximal heart rate decrease. Aging process have effect in adrenergic signal that relate to elevate symphathetic neurotransmitter [15]. Renin – angiotensis system (RAS) activated by cardiomyocytes and fibroblast. RAS signalling work with Angiotensin II (ANGII) and growth factor beta (TGF – β) affect hypertrophy of the cardiomyocytes. Angiotensin II (ANGII) responsible at tissue remodeling and inflammation. But. Signalling pathway of ANG II need another report study[15]. Every sign that caused by aging make heart become different. Cardiac output will be decrease and heart rate will increasingly slowly. In study earlier, exercise heart rate between young and elderly resulted that elderly had 30 second slower increase [16]. Beside that, response to β- adrenergic will reduce and make relaxation response will decrease.

The aorta stiffness, hypertrophic left ventricle and endothelial dysfunction related with ROS production are the impact of aging process in cardiac structure and function [9]. The aging process causes structural disorders of the artery walls in the form of atherosclerosis. The key causes of impaired vascular endothelial function through excessive development of superoxide (O2-) are oxidative stress and inflammation. Inflammatory cytokine increases collagen deposition, elastin fragmentation, protein (nitrotyrosine) oxidation, and the formation of advanced glycation end products (AGEs). With age increased, it becomes irregular, which leads to the decrease of rate and amount of nitric oxide (NO) absorption and vascular endothelial dysfunction [17].

These healthy lifestyle with low intensity of physical activity and aging process, impact cardiovascular health. Therefore, lifestyle intervention, such as increasing rate of exercise and physical activity, are needed to against CVD.

CYCLING FOR CARDIOVASCULAR HEALTH

Cardiovascular health is dependent on the presence of cardiovascular risk factors. Therefore, preventive measures taken against cardiovascular risk factors has never been more important.

Cycling is one of type of aerobic exercise, that could sustain or restore vascular endothelium efficiency by decreasing the production of oxidative stress and age-related inflammation [17].

Changes in the structure of the vascular endothelium due to physical activity starts from the formation of nitric oxide (NO) which is important in increasing vasodilation of blood vessels. Reactive Oxygen Species (ROS) acts to deactivate NO bioavailability. During physical activity, there was an increase in SOD activity due to increased shear stress in the blood vessel walls as well as a positive feedback mechanism where NO was known to enhance extracellular SOD output [18].

Physical activity has been known to be able to reduce cardiovascular risk such as elevated blood pressure, insulin resistance and glucose intolerance, elevated triglyceride concentrations, low high-density lipoprotein cholesterol (HDL-C) and high low-density lipoprotein cholesterol (LDL-C) concentrations, and obesity [19].

Physical activity can be differentiated into two types which are the aerobic and anaerobic exercises based on the oxygen consumption during activity, both of which are beneficial in reducing cardiovascular risks [19].

Bicycling is considered as one of the most common aerobic exercises. People who spent 1 hour every week bicycling for pleasure participated in an additional 3 MET h/day of recreational physical activity (equivalent to approximately 36 min/ day of moderate intensity physical activity). Cycled for more than 1 hour spent an additional 7.9 MET h/day in moderate-to-vigorous physical activity (equivalent to 94.8 min/day of moderate intensity physical activity) compared to people who did not [20].

A study reported that cycling had a great impact in reducing cardiovascular risk factor. Compared to non-cyclist, cardiorespiratory fitness (CRF) is higher. Blood lipid (total cholesterol, triglyceride, and LDL) lower than non-cyclist, and HDL is higher than non-cyclist. According to the study, there is no meta – analysis about associations cycling and CVD risk factor [21]. Indoor cycling also can reduce systolic and diastolic blood pressure. In 6 months intervention combining with diet may raising HDL, reducing triglycerides, total cholesterol and LDL [22].

Previous study by Grøntved A *et al.*, a 10 year-period cohort, has shown that bicycling to work is beneficial in preventing cardiovascular risk. The cardiovascular risk assessed in the study includes obesity, hypertension, hypertriglyceridemia, and impaired glucose tolerance. It was reported that cycling to work has lowered the incident of obesity (OR=0.64, 95% CI 0.49–0.84, $P<0.001$), hypertension (OR=0.88, 95% CI 0.75–1.03), hypertriglyceridemia (OR=0.76, 95% CI 0.62–0.92, P=0.006), and impaired glucose tolerance (OR=0.79, 95% CI 0.68–0.93, P=0.005) compared to passive travel (car/public transportation). Furthermore, it is shown that there is dose-dependent relationship between bicycling distance and reduction of cardiovascular risk in which the length of the distance travelled is inversely proportional to the incident of cardiovascular risk [23].

THE MECHANISMS OF CYCLING-INDUCED BENEFITS IN CARDIOVASCULAR HEALTH

Cycling is one of type of aerobic exercise, that could sustain or restore vascular endothelium efficiency by decreasing the production of oxidative stress and age-related inflammation [17].

Changes in the structure of the vascular endothelium due to physical activity starts from the formation of nitric oxide (NO) which is important in increasing vasodilation of blood vessels. Reactive Oxygen Species (ROS) acts to deactivate NO bioavailability. During physical activity, there was an increase in SOD activity due to increased shear stress in the blood vessel walls as well as a positive feedback mechanism where NO was known to enhance extracellular SOD output [18].

Decrease in maximal aerobic capacity is one of the important physiological changes that occur during advanced aging process as characterized by maximum exercise oxygen consumption. This reduction in aerobic capacity can be attributed to changes in oxygen distribution to the active muscles during exercise (i.e. heart function) or the ability of the muscles to utilize oxygen [24].

A randomized study shows that level of cardiovascular fitness could be increased through an aerobic cycling program as measured by peak VO2. The improvement in cardiovascular fitness from aerobic exercise is a result of the central or peripheral mechanisms related to the transport and utilization of oxygen [25].

The carotid arteries are a pair of blood vessels located on the inside of the neck, connecting the aortic vessels from the heart to the brain. Previous studies have shown that the risk of cardiovascular disease is higher in the intima-media walls of the carotid arteries. In addition, the risk of coronary artery disease and stroke increases if the examination results reveal that the carotid intima media thickness (CIMT) is> 1 mm. VO2max is associated with CIMT. The incidence of carotid arteriosclerosis has a higher risk of low VO2max. Thus, cardiorespiratory fitness provides important data in the prevention of CV disease [26].

Association between physical age and activity that make changes in exercise efficiency and maximal aerobic capacity are described through decrease level of mitochondrial respiratory and enzyme activity in the elderly population. However, elderly who are doing exercise has been shown to increase the density of capillary blood vessels and activity of the enzymes in the mitochondria to the same level as young individuals [24].

Heart Rate Recovery (HRR) is a measure of autonomic function that reflects the function of the parasympathetic and sympathetic nerves in the post-exercise recovery phase. Several recent studies have shown that HRR can be a prognostic sign in subjects with or without cardiovascular disease. There is an imbalance in autonomic nerve function related with vagal tone deficiency that could lead to death [25].

The results of clinical examinations of groups of people without cardiovascular disease show that a higher activity rate results in a greater left ventricular mass as well as lower diastolic volume and resting heart rate [24].

CHANGES IN CARDIOVASCULAR RELATED TO EXERCISE TRAINING AND CYCLING

Cardiovascular and skeletal muscle function are two most important components during physical exercise. The need for oxygen in the muscle during physical activity increases in proportion to the intensity of the exercise which required an increase in cardiac output, as well as myocardial oxygen demand. The fulfillment of this demand is dependent on the nutrients and oxygen supply from the coronary arteries. Previous studies have shown that there are morphological and functional changes to the vascular system in a population with regular physical activity. These changes increase blood flow during physical activity, with normal wall shear stress and blood velocity [18].

Changes in the blood vessel due to physical activity, starts with nitric oxide (NO) which is the derivative of endothelial isoform of NO synthase (eNOS). NO is important in promoting vasomotion in blood vessel as well as vasodilation. During physical activity, due to the higher demand for oxygen in the muscles, there will be an increase in shear stress on the blood vessel wall which has been shown to enhance eNOS mRNA and protein expression, therefore increasing the production of vascular NO [18].

Previous studies have also shown that the bioavailability of NO is also dependent on its inactivation by reactive oxygen species (ROS). To combat the inactivation of NO by ROS, the enzyme superoxide dismutase (SOD) is crucial, because it helps limit the amount of ROS available and therefore increasing the bioavailability of NO. During physical activity, it has been shown that there is an increase of SOD activity due to increasing wall shear stress, furthermore, it has also been shown that there is a positive feed-forward mechanism in which NO was found to increase extracellular SOD expression [18].

Long-term period of exercise can result in further remodeling of the blood vessel which is mediated by cytokines and growth factors. These cytokines and growth factors lead to proliferation and growth of endothelial and smooth muscle cells which resulted changing the structure of the capillaries into that of an artery. Furthermore, these changes also occur in the arterioles, coronary resistance vessels, and large proximal conduit vessels [18].

Further studies have also found the circulating progenitor cell (CPC) which is a bone-marrow derived cell that plays a role in vasculogenesis. During long-term regular physical activity, CPCs function to repair the damaged endothelium, enhanced neo-angiogenesis, reduce neointima formation. These CPC cells mobilization is dependent on NO which in turns activate matrix metalloproteinases 2 and 9. Furthermore CPCs function and number have been found to be dependent on NO bioavailability [18].

EVALUATION EFFECT OF CYCLING IN CARDIOVASCULAR HEALTH

Cardiac output (CO) is a very important assessment of heart function during exercise. The CO assessment is performed to evaluate cardiovascular factors that can limit oxygen transport. Measurement of CO allows researchers to determine possible physiological responses and adaptation mechanisms induced by physical training, sedentary lifestyle or chronic disease. CO is a product of stroke volume (SV) and heart rate (HR) which represents the body's ability to meet the metabolic needs of sports, where during exercise, the body's metabolic needs can increase five to six times. The functions of the autonomic nervous system such as the fast and continuous parasympathetic coupled with sympathetic activation are needed so that the body's needs can be fulfilled. Cycling is widely used for physical training around the world and is a powerful stimulant of myocardial adaptations [27].

Cycling includes strength and resistance sports that involve a combination of dynamic and static combined large muscle group exercises. During maximal exercise, the systolic HR increases close to the maximum value, with the peak systolic blood pressure reaching> 200 mm Hg. After cycling, HR, SV and CO were significantly higher than at rest. The increase in CO during cycling will increase the flow of oxygen and nutrients to the tissues, thereby reducing oxidative stress in the body [27].

The physiological adaptation of the heart can be found in cyclist endurance training as evidenced by echocardiography examination and normal levels of cardiac biomarkers [28].

The results of the meta-analysis showed slightly different cardiac adaptations between dynamic, static, and moderate sports in an athlete. Endurance and strength-trained cyclists showed significant increases in heart wall thickness and greatest increases in left ventricular internal diameter as an adaptive mechanism [27].

Endocrine and paracrine factors are known to play an important role in the mechanism of the cardiac remodeling process related to resistance training [28].

Cardiorespiratory fitness can be assessed by measuring VO2max which represents an estimated exercise capacity and is known to have a protective effect against cardiovascular disease. In healthy individuals, maximal oxygen consumption (VO2max) can consistently be increased after resistance training [26]. Cycling is known to trigger several phenotypic modifications, including cycling to increase blood volume, increase in heart structure / function, oxygen-carrying capacity in the blood, skeletal muscle capillarization, function and number of mitochondria as well as a more efficient distribution of blood flow due to decreased resistance of peripheral blood vessels. VO2max is involved in all of these mechanisms by increasing oxygen delivery to active tissue. Any adaptations that result from resistance training based on VO2max, will result in a higher maximal cardiac output and / or difference in arteriovenous oxygen at maximal exercise [29].

OPTIMAL CYCLING FOR CARDIOVASCULAR HEALTH AND AGING PREVENTION

In terms of getting health impacts of cycling, depend on the intensity and duration. Moderate intensity physical activity has been shown to have an impact on cardiovascular health. According to previous research, regular cycling with sufficient duration and intensity will be better than cycling only once with a long duration [5].

The type, frequency, intensity and duration of exercise needed to preserve or enhance age-related endothelial vascular function is still not well understood [25]. According to the study of Hoevenaar-Blom et al., 2010, CVD risk prevalence reduced by cycling activity through a way of dose-response. Cycling ≥ 3.5 hours / week can reduce CVD risk by about 20%, but the combination of cycling > 3.5 hours / week and other sports can reduce the risk by nearly 40% [5]. Commuter who manage cycling several kilometers in one trip can improve the cardiorespiratory performance of adults with decrease level of fitness. The thresholds for cardio-respiratory health enhancement of 1000 kcal/week of women's cycling exercise and 1500 kcal/week for men will be between 170 and 250 minutes/week of moderate cycling intensity (6 MET) [5]. Although the evidence indicate the moderate-intensity aerobic exercise is necessary to maintain/improve endothelial vascular function with increasing age. Further research is required to gain insight into the appropriate category, frequency, intensity and duration of exercise [17].

To prevent the effect of aging and degenerative disease, a study shows that low-intensity cycling also improve motor function in early stage of Parkinson Disease (PD). Thirteen PD patients aged 53-59 years were enrolled in pre-training assessment and 16 serial cycling sessions were enrolled over a two-month period. In the training session, cycling begins at 15 minutes and then progressively increases the length of each session by 5 minutes and the intensity of each session around 5-10 rpm with maximal rpm 40. The post-training evaluation was carried out at the conclusion of the serial cycling session. The result show that there is improvement in motor function especially akinesia [30].

The submaximal cycling test commonly used to predict and track the outcome of the cycling. The length of the test was between 17 and 58 minutes. predicted time to exhaustion (pTE), submaximal power output, rating of perceived exertion (RPE), and heart-rate recovery (HRR), is critical for monitoring and evaluation, but as some of the outcome variables are affected by individual sensors and/or are partially influenced by the genetic factor, it is crucial to determine individual changes [31].

The 2016 European guidelines on cardiovascular disease prevention is recommended that individuals accumulate at least 30 min/day, 5 days/week of moderate intensity PA (i.e. 150 min/week) or 15 min/ day, 5 days/week of vigorous intensity PA (75 min/week), or a combination of both, performed in sessions with a duration of at least 10 min. Shorter exercise sessions (i.e. ,10 min) may also be appropriate, especially in very deconditioned individuals. For lipid control or body weight management, longer durations of exercise, 40 and 60–90 min/day, respectively, have been proposed [32].

Cycling is one of physical activity that included on the guidelines that could maintain cardiovascular health. It is recommended to do slow cycling (15 km/h) as moderate intensity with targeted 64 - 76% HR max, RPE 12 – 13, and talk test indicate that breathing is faster but compatible with speaking full sentences, also bicycling >15 km/h as vigorous intensity, with targeted 77 – 93% HR max, RPE 14 - 16, and talk test indicate that breathing very hard, incompatible with carrying on a conversation comfortably [32].

CONCLUSION

Complexity systemic processes both aging and cycling is influence the cardiovascular system. This article helps to explain the connection in physical activity, particularly cycling, with its possible mechanism for the prevention of cardiovascular disorders related with the effects of aging on cardiac structure and function, also maintaining cardiovascular health.

Increasing physical activity, including cycling was related to lower risk factors of cardiovascular diseases, such as incident of obesity, hypertension, and dyslipidemia. However, it is important to do regular cycling with sufficient duration and intensity to maximize the health advantages.

Our review had several limitations. We do not discuss the biomechanical function of the lower extremity during the cycling gait cycle and bicycling fitting to optimize the health impact. We only discuss the mechanism of cycling in general against aging and cardiovascular. Further article review is needed to evaluate those topics, modelling blood flow to describe the various characteristics of cardiovascular response, together with the factors that influence it, gaining insight into the appropriate category, frequency, intensity and length of cycling to meet the cardiovascular health goal.

Finally, it is concluded that lifestyle intervention through increasing physical activity will maintain and improve cardiovascular health.

CONFLICT OF INTEREST

No conflict of interest is declared by the authors.

ACKNOWLEDGEMENT

Authors would like to thank Anti-Aging Medicine Post Graduate Program Biomedic Medical Faculty Universitas Udayana and Physiology Department Medical Faculty Universitas Udayana for the opportunity to write this article and Ms. Luh Putu Ratna Sundari for proof reading the manuscript.

REFERENCES

1. Maharani A, Sujarwoto, Praveen D, Oceandy D, Tampubolon G, Patel A. Cardiovascular disease risk factor prevalence and estimated 10-year cardiovascular risk scores in Indonesia: The SMARThealth Extend study. PLoS One. 2019;14(4):1–13.
2. Götschi T, Garrard J, Giles-Corti B. Cycling as a Part of Daily Life: A Review of Health Perspectives. Transp Rev. 2016;36(1):45–71.
3. Pinckard K, Baskin KK, Stanford KI. Effects of Exercise to Improve Cardiovascular Health. Front Cardiovasc Med. 2019;6(June):1–12.
4. Fajemiroye JO, Cunha LC Da, Saavedra-Rodríguez R, Rodrigues KL, Naves LM, Mourão AA, et al. Aging-Induced Biological Changes and Cardiovascular Diseases. Biomed Res Int. 2018;2018.
5. Oja P, Titze S, Bauman A, de Geus B, Krenn P, Reger-Nash B, et al. Health benefits of cycling: A systematic review. Scand J Med Sci Sport. 2011;21(4):496–509.
6. Andersen LB, Wedderkopp N, Kristensen P, Moller NC, Froberg K, Cooper AR. Cycling to school and cardiovascular risk factors: A longitudinal study. J Phys Act Heal. 2011;8(8):1025–33.
7. Piché ME, Poirier P, Lemieux I, Després JP. Overview of Epidemiology and Contribution of Obesity and Body Fat Distribution to Cardiovascular Disease: An Update. Prog Cardiovasc Dis [Internet]. 2018;61(2):103–13. Available from: https://doi.org/10.1016/j.pcad.2018.06.004
8. Fukushima A, Lopaschuk GD. Cardiac fatty acid oxidation in heart failure associated with obesity and diabetes. Biochim Biophys Acta - Mol Cell Biol Lipids [Internet]. 2016;1861(10):1525–34. Available from: http://dx.doi.org/10.1016/j.bbalip.2016.03.020
9. Paneni F, Diaz Cañestro C, Libby P, Lüscher TF, Camici GG. The Aging Cardiovascular System: Understanding It at the Cellular and Clinical Levels. Journal of the American College of Cardiology. 2017.
10. Rockey DC, Bell PD, Hill JA. Fibrosis — A Common Pathway to Organ Injury and Failure. N Engl J Med. 2015;
11. Steenman M, Lande G. Cardiac aging and heart disease in humans. Biophysical Reviews. 2017.
12. Tocchi A, Quarles EK, Basisty N, Gitari L, Rabinovitch PS. Mitochondrial dysfunction in cardiac aging. Biochim Biophys Acta - Bioenerg. 2015;
13. Taneike M, Yamaguchi O, Nakai A, Hikoso S, Takeda T, Mizote I, et al. Inhibition of autophagy in the heart induces age-related cardiomyopathy. Autophagy. 2010;
14. Nakou ES, Parthenakis FI, Kallergis EM, Marketou ME, Nakos KS, Vardas PE. Healthy aging and myocardium: A complicated process with various effects in cardiac structure and physiology. International Journal of Cardiology. 2016.
15. Lemarié CA, Schiffrin EL. The angiotensin II type 2 receptor in cardiovascular disease. JRAAS - Journal of the Renin-Angiotensin-Aldosterone System. 2010.
16. Someya F, Mugii N, Oohata S. Cardiac hemodynamic response to the 6-minute walk test in young adults

and the elderly. BMC Res Notes. 2015;
17. Santos-Parker JR, LaRocca TJ, Seals DR. Aerobic exercise and other healthy lifestyle factors that influence vascular aging. Adv Physiol Educ. 2014;38(4):296–307.
18. Winzer EB, Woitek F, Linke A. Physical activity in the prevention and treatment of coronary artery disease. J Am Heart Assoc. 2018;7(4):1–15.
19. Vanhees L, Geladas N, Hansen D, Kouidi E, Niebauer J, Reiner Ž, et al. Importance of characteristics and modalities of physical activity and exercise in the management of cardiovascular health in individuals with cardiovascular risk factors: Recommendations from the EACPR (Part II). Eur J Prev Cardiol. 2012;19(5):1005–33.
20. Sahlqvist S, Goodman A, Simmons RK, Khaw KT, Cavill N, Foster C, et al. The association of cycling with all-cause, cardiovascular and cancer mortality: Findings from the Population-based EPIC-Norfolk cohort. BMJ Open. 2013;3(11).
21. Nordengen S, Andersen LB, Solbraa AK, Riiser A. Cycling and cardiovascular disease risk factors including body composition, blood lipids and cardiorespiratory fitness analysed as continuous variables: Part 2 - Systematic review with meta-analysis. British Journal of Sports Medicine. 2019.
22. Chavarrias M, Carlos-Vivas J, Collado-Mateo D, Pérez-Gómez J. Health benefits of indoor cycling: A systematic review. Medicina (Lithuania). 2019.
23. Grøntved A, Koivula RW, Johansson I, Wennberg P, Østergaard L, Hallmans G, et al. Bicycling to work and primordial prevention of cardiovascular risk: A cohort study among Swedish men and women. J Am Heart Assoc. 2016;5(11).
24. Jakovljevic DG. Physical activity and cardiovascular aging: Physiological and molecular insights. Exp Gerontol. 2018;109:67–74.
25. Jin H, Jiang Y, Wei Q, Chen L, Ma G. Effects of aerobic cycling training on cardiovascular fitness and heart rate recovery in patients with chronic stroke. NeuroRehabilitation. 2013;32(2):327–35.
26. Heart IJC, Kang S, Ko K. Association between resting heart rate , VO 2 max and carotid intima- media thickness in middle-aged men. IJC Hear Vasc [Internet]. 2019;23:100347. Available from: https://doi.org/10.1016/j.ijcha.2019.100347
27. Horn P, Ostadal P, Ostadal B. Rowing Increases Stroke Volume and Cardiac Output to a Greater Extent Than Cycling. 2014;(May 2020).
28. Sikora M, Mikrut G. Hormonal Response to Incremental and Continuous Exercise in Cyclists with Left Ventricle Hypertrophy. 2020;71(January):155–66.
29. Montero D. Endurance training and maximal oxygen consumption with ageing : Role of maximal cardiac output and oxygen extraction. 2016;
30. Chang HC, Lu CS, Chiou W Da, Chen CC, Weng YH, Chang YJ. An 8-week low-intensity progressive cycling training improves motor functions in patients with early-stage Parkinson’s disease. J Clin Neurol. 2018;14(2):225–33.
31. Capostagno B, Lambert MI, Lamberts RP. A systematic review of Submaximal cycle tests to predict, monitor, and optimize cycling performance. Int J Sports Physiol Perform. 2016;11(6):707–14.
32. Piepoli MF, Hoes AW, Agewall S, Albus C, Brotons C, Catapano AL, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J. 2016;37(29):2315–81.