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LIFESTYLE DETERMINANT OF PATIENTS WITH CORONARY HEART DISEASE: A SYSTEMATIC REVIEW

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Abstract

Coronary Heart Disease (CHD) is a chronic disease that causes death number one in the world. Coronary Heart Disease has a long development period so it can be prevented by modifying lifestyle early on. This systematic review aims to assess the influence of lifestyle on the incidence of CHD in people worldwide. The research design used a systematic review method, with a search of the PubMed, ScienceDirect and ResearchGate electronic databases, identifying 10 relevant articles published from 1 January 1997 to 9 Maret 2023. Analysis of the accompanying articles shows that a diet with excessive carbohydrate and fat consumption increases the risk of CHD. However, consumption of vegetables and fruits has the potential to reduce the risk of CHD. Low physical activity increases the risk of CHD. The risk of CHD in smokers is influenced by the number of cigarettes, and an obese body mass index causes atherosclerosis thereby increasing the risk of CHD. This systematic review concluded that lifestyle factors that increase the risk of CHD in people around the world are diets high in carbohydrate and fat consumption, low physical activity, smoking and obesity.

Keywords: Coronary Heart Disease, Dietary Habit, Physical Activity.

INTRODUCTION

Coronary Heart Disease (CHD) or what is commonly called coronary artery disease refers to a pathological process that affects the coronary arteries which is usually caused by atherosclerosis. The occurrence of atherosclerosis is caused by the presence of plaque which causes hardening and thickening of the walls of blood vessels. In addition, plaque formation can also slow down or stop blood flow so that the tissues that are supplied by the arteries will experience a lack of oxygen and nutrients (Damasceno, 2016).

Based on WHO data in 2020, CHD causes the loss of 9.4 million lives and more than 203 million people live with disabilities every year (Smoke, 2020). Based on Heart Disease and Stroke Statistics in 2022, CHD is the number 1 cause of death in the United States. CHD accounted for approximately 12.6% (360,900) of deaths in 2018. According to data from 2005 to 2014, the estimated annual incidence of heart attacks in the United States is 605,000 new attacks and 200,000 recurrent attacks. The average age of first heart attack was 65.6 years for men and 72.0 years for women. Approximately every 40 seconds, someone in the United States will have a myocardial infarction and the estimated direct and indirect costs of heart disease in 2017 to 2018 (annual average) is 228.7 billion (Wang et al., 2021).

The American Heart Association (AHA) measures cardiovascular health by tracking seven major health factors and behaviors that increase the risk of heart disease and stroke. The AHA call them “Life's Simple 7” and measure them to track progress toward improving heart health for everyone. Life's Simple 7 covers health behaviors (such as: smoking, physical activity, diet/diet, and body weight) and health factors

(such as: cholesterol, blood pressure, and glucose control) that contribute to cardiovascular health (Virani et al., 2021).

CHD is still a health problem that must be addressed immediately to prevent an increase in mortality. CHD has a long duration of disease progression. Therefore, the occurrence of CHD must be prevented early by taking into account the risk factors. This can be done by modifying lifestyles for the better such as a good diet, doing physical activity, and not smoking. This systematic review was conducted with the aim of finding out how lifestyle factors affect CHD events based on the results of studies conducted on adults in various parts of the world.

METHODS

The method used in this study is a systematic review to systematically review previously published articles related to lifestyle factors that influence CHD events. Systematic reviews are carried out according to the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) regarding the writing of systematic review reports. A literature search was conducted in January 2023 with a limit of articles published from 1997 to 2023 through the PubMed, ResearchGate and ScienceDirect electronic databases. Article searches were carried out using the keywords “coronary heart disease”, “cigarette or smoke”, “physical activity”, “dietary habit or dietary pattern”, and “obesity”.

The process of selecting the reviewed studies is shown in (Figure 1). Data were taken from each study that had inclusion criteria: 1) reported lifestyle and CHD, 2) were quantitative research articles, 3) journals were published in English, and 4) fully accessible. Articles in the form of proceedings and literature studies were excluded in this study. This systematic review used guidelines to analyze the quality of the literature among selected studies. The guidelines used are the Critical Appraisal Skills Program (CASP) and Quality Assessment to assess the risk of bias from the selected studies.

RESULTS

The initial search resulted in 1892 articles obtained from all databases and screening was carried out so that the selected articles totaled 92 articles. The first author filters the titles and abstracts of the articles that have been obtained. Next, each author read the full text of the article and defended the articles that met the inclusion and exclusion criteria through discussion between authors. In the end, 10 articles were obtained that met the inclusion and exclusion criteria. The synthesis of the articles is presented in (Table 1).

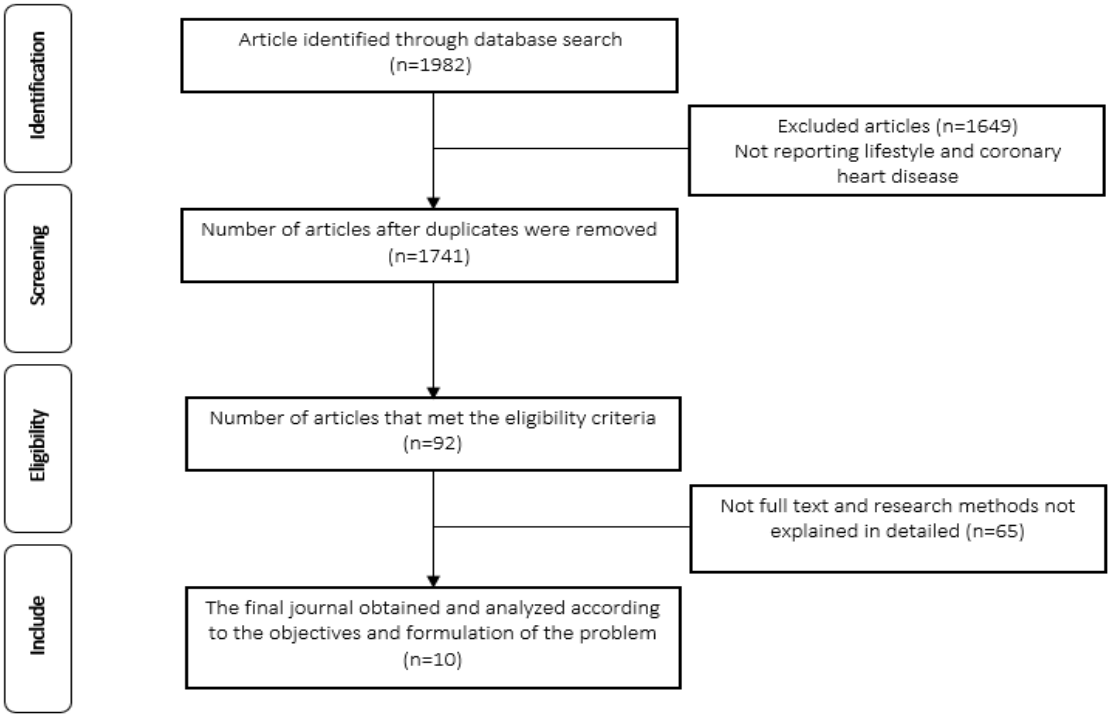

Figure 1: PRISMA Flow Diagram

Table 1: Article Synthesis

No.	Researchers, Publications, Research Titles	Research Samples	Method	Variable	Result
1.	Robert J. Glynn[1], and Bernard Rosner[2]. American Journal of Epidemiology (2005); 162: 975-982. Comparison of Risk Factors for the Competing Risks of Coronary Heart Disease, Stroke, and Veneous Thromboembolism (Glynn & Rosner, 2005).	Study participants were 22,071 US male physicians aged 40-84 years with no history of cancer, myocardial infarction, stroke, or transient cerebral ischemia.	Cohort study	Independent variable: smoking	This study reveals that smoking is associated with an increase in coronary heart disease. The *OR* value was 1.84 (p <0.05; 95% *CI*: 1.62 - 2.08), indicating that people who smoke have a 1.84 times greater chance of experiencing coronary heart disease than people who don't smoke (Glynn & Rosner, 2005).
2.	Blanaid Hicks[1], Giovanni Veronesi[2], Marco M. Ferrario[3], Hannah Forest[4] Margaret Whitehead[5] and Finn Diderichsen[6]. Jurnal Epidemiol Community Health (2021); 75: 1147-1154. Roles of Allostatic Load,	The research sample was 25,310 men and 26,018 women aged 35-74 years	Cohort study	Independent variables: smoking, and body mass index	This study reveals that smoking and body mass index (obesity) are associated with an increase in coronary heart disease. This is indicated by the value of p <0.0001 (Hicks et al., 2021).

	Lifestyle and Clinical Risk Factors in Mediating the Association Between Education and Coronary Heart Disease Risk in Europe (Hicks et al., 2021)				
3.	Thierry Lang[1], Pierre Ducimetiere[2], Dominique Arveiler[3], Philippe Amouyel[4] and Jean Pierre Cambou[5]. International Journal of Epidemiology, (1997) Vol. 26 No. 1. Incidence, Case Fatality, Risk Factors of Acute Coronary Heart Disease and Occupational Categories In Men Aged 30–59 in France (Lang et al., 1997).	Subsample of 1863 men aged 30-59 were used for this analysis	Case control study	Independent variable: smoking	This study reveals that smoking is associated with an increased incidence and case fatality of all coronary events. This is indicated by the value of *p* 0.02 (Lang et al., 1997).
4.	Maarten J. G. Leening[1], Nancy R. Cook[2], Oscar H. Franco[3], JoAnn E. Manson[4], Kamakshi Lakshminarayan[5] and Michael J. LaMonte[6]. Journal of the American Heart Association, (2017). Comparison of Cardiovascular Risk Factors for Coronary Heart Disease and Stroke Type in Women (Leening et al., 2018).	Comparing 1731 women with cardiovascular disease events during follow-up with a cohort of 1914 women.	Case-cohort study	Independent variable: smoking	This study reveals that smoking is a risk factor for coronary heart disease. This is indicated by the value of *p-value* <0.0001 (Leening et al., 2018).
5.	Yan-Fang Wan[1], Xiao-Li Ma[2], Chen Yuan[3], Ling Fei[4], Jin Yang[5] and Jun Zhang[6]. Experimental and Therapeutic Medicine, (2015); 10: 1115-1120. Impact Daily Lifestyle on Coronary Heart Disease (Wan et al., 2015).	The study sample was 129 patients with CHD who were treated at the Cangzhou Central Hospital of Hebei Medical University	Cohort study	Independent variables: smoking and physical activity	Multivariate logistic regression analysis revealed that tobacco use, and physical activity significantly impact CHD. The *OR* value was 11.71 (*p-value* < 0.001; 95% *CI*: 3.95-34.71) which indicated that people who used tobacco had a 11.71 times greater chance of experiencing coronary heart disease than people

					who did not use tobacco. *OR* value of 0.14 (*P-VALUE* 0.013; 95% *CI*: 0.02-0.65) which indicates that people who do not do physical activity have a 0.14 times greater chance of experiencing coronary heart disease than people who do physical activity ≥3 times a week for at least 1 hour (Wan et al., 2015).
6.	Teresa T. Fung[1], Walter C. Willet[2], Meir J. Stampfer[3], JoAnn E. Manson[4] and Frank B. Hu[5]. American Medical Association, (2001); 161: 1857-1862. Dietary Patterns and the Risk of Coronary Heart Disease in Woman (Investigation, 2001).	The study sample was 69,017 women aged 38 to 63 years without a history of major chronic diseases	Cohort study	Independent variable: diet	This study identified 2 dietary patterns, namely a cautious pattern characterized by higher intakes of fruit, vegetables, whole grains, legumes, poultry, and fish. On the other hand, the Western pattern is characterized by higher intakes of red and processed meat, high-fat dairy products, french fries, refined grains, and desserts and sweets. The results of the study found a significant inverse relationship between the precautionary pattern and CHD risk and a positive relationship between the Western pattern and CHD risk. The *OR* value is 0.70 (95% *CI*, 0.56-0.86) for the cautious pattern and 1.64 (1.24-2.17) for the Western pattern. So it can be concluded that a diet high in fruits, vegetables, whole grains, nuts, poultry, and fish and low in refined grains, potatoes, and red and processed meat can

					reduce the risk of CHD (Investigation, 2001).
7.	Mihaela Tanasescu[1], Michael F. Leitzmann[2], Eric B. Rimm[3], Walter C. Willet[4], Meir J. Stampfer[5] and Frank B. Hu[6]. American Medical Association, (2007). Exercise Type and Intensity in Relation to Coronary Heart Disease in Men (Leitzmann et al., 2002).	The research sample was 44452 US men aged 40 to 75 years	Cohort study	Independent variable: physical activity	This study revealed that average exercise intensity was associated with a reduced risk of CHD regardless of the total volume of physical activity. *OR* (95% *CI*) corresponding to moderate (4-6 MET) and high (6-12 MET) activity intensity were 0.94 (0.83-1.04) and 0.83 (0.72-0, 97) compared to low activity intensity (4 MET) (*p-value*=0.02) (Leitzmann et al., 2002).
8.	Ralph A. H. Stewart[1], Claes Held[2], Nermin Hadziosmanovic[3], Paul W. Amstrong[4], Christopher P. Cannon[5], Christopher B. Granger[6] and Emil Hangstrom[7]. Journal of The American College of Cardiology Vol. 70. No. 14, (2017). Physical Activity and Mortality in Patients With Stable Coronary Heart Disease (Cannon et al., 2017).	Subjects from 39 countries (n = 15,828) were randomized. All patients had chronic stable CHD	Cohort study	Independent variable: physical activity	This study revealed that more physical activity was associated with a lower coronary heart disease risk score with interaction (*p-value* = 0.0007) (Cannon et al., 2017).
9.	I-Min Lee[1], Kathryn M. Rexrode[2], Nancy R. Cook[3], JoAnn E. Manson[4], and Julie E. Buring[5]. American Medical Association, Vol 285, No. 11, (2001). Physical Activity and Coronary Hearth Disease in Women (I. Lee et al., 2001).	Cohort study of 39372 healthy female health professionals aged 45 years or older	Cohort study	Independent variable: physical activity	The results of this study indicate that even mild to moderate activity is associated with lower rates of CHD in women. At least 1 hour of walking per week predicts lower risk. There is also an inverse relationship with physical activity in women who are at high risk of CHD, including those who are overweight, have elevated cholesterol levels, or are smokers (I. Lee et al., 2001).

10.	Howard D. Sesso[1], Ralph S. Paffenbarger[2] and I-Min Lee[3]. American Heart Association, (2000). Physical Activity And Coronary Heart Disease in Men (Sesso et al., 2000).	Study sample of 12,516 middle-aged and older men (mean age 57.7 years, range 39 to 88 years)	Cohort study	Independent variables: physical activity, and smoking	This study revealed that total physical activity and strenuous physical activity showed the strongest reduction in CHD risk (p value = 0.001). Moderate and light activity, showed no significant inverse relationship. The relationship between physical activity and reduced risk of CHD also extends to men with several coronary risk factors such as smoking, alcohol consumption, diabetes mellitus and hypertension (Sesso et al., 2000).

DISCUSSION

Based on the journals that have been reviewed, the lifestyle of CHD sufferers can be identified from diet, physical activity, smoking and body mass index (obesity), as described below:

1. Diet

In this literature review, the authors identified twelve journal articles related to diet as a risk factor for coronary heart disease. The change in lifestyle that has led to a modern lifestyle has had an impact on eating patterns in society, where people no longer consume a balanced diet consisting of various types of food with complete and balanced nutritional content, but tend to consume foods that contain high fat, especially saturated fat, cholesterol, and low in fiber (Chaeroni et al., 2021; Sieri et al., 2020).

This is in accordance with a study conducted in the United States, which reported that the risk of CHD was significantly lower when energy intake from carbohydrates such as whole grains was higher (*OR = 0.90 [95% CI: 0.83 - 0.98], p-value = 0.003)* and significantly higher with increased intake of carbohydrates from refined starches or added sugars (*OR* = 1.10 [95% *CI*: 1.00 - 1.21], *p-value* = 0.04) (Li et al., 2016). The excess amount of carbohydrates that enter the body will be stored in the form of body fat. Excess body fat affects total cholesterol levels in the blood, which is a risk factor for CHD (Amato et al., 2020a; Chaeroni et al., 2022).

Fatty or cholesterol foods have a relationship with CHD risk. In this systematic review, there are 3 research articles that analyze the relationship between consumption of fatty/cholesterol foods and the incidence of CHD. A cohort study study conducted in the United States found that participants who consumed fatty foods or foods containing cholesterol every day had one to two times greater risk of developing CHD (Investigation, 2001; Welis et al., 2022). Fat is a component that has a major influence on the regulation of cholesterol metabolism. High levels of fat in food can increase total cholesterol levels in the blood and form deposits on the walls of blood vessels,

causing narrowing of the arteries or commonly called atherosclerosis. Atherosclerosis in the blood vessels of the heart can cause CHD (Hu et al., 2000; Ihsan et al., 2021).

The results showing no difference between the consumption of fatty/cholesterol foods and the incidence of CHD in this review were reported in one study. Research conducted in West Sumatra, Indonesia showed different results from previous research, where the relationship between fat consumption and CHD was not found with the acquisition of a *p-value* > 0.05. The absence of a relationship between the consumption of fatty/cholesterol foods and the incidence of CHD in this study was possible because interviews regarding the consumption habits of foods containing cholesterol were limited to types of foods that had a cholesterol content of more than 300 mg/dl which were consumed daily and were limited to types side dishes only (Mmedsci et al., 2004).

Lack of fruit and vegetable consumption has an important role in the incidence of CHD. A total of four studies in this review discussed the relationship between consumption of fruits and vegetables and the incidence of CHD, and all four studies showed a relationship. Research conducted on Jordanians with a case-control study design showed a p value <0.05 which could be interpreted as a significant relationship between a vegetarian diet and a reduced risk of CHD compared to those who did not have a vegetarian diet (Tayyem et al., 2017). The more fruit and vegetable consumption, the more beneficial it will be for heart health. Fiber found in fruits and vegetables functions to inhibit fat absorption and can indirectly lower cholesterol levels so that the risk of CHD also decreases (Investigation, 2001). Vegetarian diets are also beneficial in controlling body weight, blood lipid levels, and blood pressure which are associated with CHD incidence and mortality (Weikert et al., 2005).

2. Physical Activity

Physical activity can be defined as body movements generated by the skeletal muscles and resulting in energy expenditure (Al-zoughool, 2018). Physical activity is a modifiable CHD risk factor. Various activities can be done to improve health with physical activities such as gymnastics, running, cycling, and others. Physical activity can also be a reference in preventing important non-pharmacological CHD that needs attention (Wan et al., 2015).

In this review, there are seventeen research articles that discuss the relationship between physical activity and CHD events, where all articles report a relationship between physical activity and CHD events. One study conducted in China showed that people who do not do physical activity are 0.14 times more likely to experience coronary heart disease than people who do physical activity ≥ 3 days a week for at least 1 hour(Wan et al., 2015). The same thing was shown by a study conducted in India with the results showing a positive relationship between sedentary activities outside of work and CHD risk, people with sedentary activities > 3.6 hours per day (for example, watching television) had an increased risk of 1.88 (95% *CI*: 1.09, 3.20) compared to < 70 minutes per day(Rastogi et al., 2004). A cohort study conducted in America revealed that more physical activity was associated with a lower coronary heart disease risk score (*p-value*= 0.0007) (Cannon et al., 2017).

People who lack physical activity can affect blood flow in the collateral vessels and coronary arteries to decrease so that it can cause reduced blood flow to the heart. Research related to lifestyle, namely on physical activity behavior conducted in America, shows that even mild to moderate activity is associated with lower CHD rates

in women. At least 1 hour of walking per week predicts lower risk. There is also an inverse relationship with physical activity in women who are at high risk of CHD, including those who are overweight, have elevated cholesterol levels, or are smokers (I. Lee et al., 2001). That's because high physical activity can increase energy expenditure, increase the resting metabolic rate, and accelerate the mobilization of fat stores so that more carbohydrates and fats will be burned to produce energy (Cannon et al., 2017).

Physical exercise activity will affect changes in the cardiovascular system, namely related to increased cardiac output and redistribution of blood flow. Other positive effects of regular exercise are reducing blood cholesterol and fat levels, reducing systolic blood pressure, increasing HDL lipoprotein levels, and improving coronary circulation (Colditz et al., 2011). In addition, regular physical activity or exercise also has an effect on increasing blood flow and helping to break down fat and cholesterol metabolism in the body (I. Lee et al., 2003).

The results showing a lack of association between CHD and physical activity in this review were reported in one study. Research conducted in rural central India showed different results from previous studies. In this study, the lack of association between CHD and physical activity can be explained by several reasons. In the age group >60 years in this study, it is likely that these factors will not have a significant effect (Bodkhe et al., 2019).

3. Smoke

Based on the results of the article search, twenty two articles were found discussing smoking and CHD that were adjusted to the inclusion criteria in this study. Twenty of the articles showed a relationship between smoking behavior and the incidence of CHD. This shows that there is a close relationship between smoking and the incidence of CHD.

Research conducted in France revealed that smoking is associated with an increased incidence and case fatality of all coronary events. This is indicated by the value of P = 0.02 (Lang et al., 1997). The US study showed that the risk of CHD was significantly higher in current smokers compared to never smokers (*OR* = 2.11, 95% *CI*: 1.39-3.18). In addition, in the multivariable logistic regression model, current smokers have a greater chance of coronary artery calcification score > 0 compared to never smokers (*OR* = 2.63, 95% *CI*: 1.88-3.68) (Oshunbade et al., 2021).

Someone who smokes will inhale the smoke from burning cigarettes which causes reduced oxygen levels that enter so that it encourages the heart to work harder. Carbon monoxide (CO) forms carboxyhaemoglobin (COHb) which causes reduced binding capacity of hemoglobin resulting in dysfunction of blood vessels. Inhaled cigarette smoke can stimulate the production of adrenaline and noradrenaline which make the heart beat harder so that blood pressure will increase. In addition, there is also a disturbance in blood flow and oxygenation due to the presence of a substance from tobacco in the form of nicotinic acid which triggers the release of catecholamines. Smoking can trigger the formation of thrombus or blood clots and calcification of blood vessel walls. The thrombus that forms can inhibit blood flow due to platelet adhesion. Smoking can also increase cholesterol and free fatty acids which cause blood vessels in the heart to narrow. Smokers have low levels of HDL blood cholesterol which indicates that there is a decrease in CHD protective elements (Outcomes, 2018).

The more cigarettes consumed, the greater the chance of CHD. This is evidenced from research conducted in China, Malay and Asian India that an increased risk of CHD was found in smokers > 20 packs per year (*OR* = 1.5, 95% *CI*: 0.9-2.5) but not with lower numbers (J. Lee et al., 2001). The more cigarettes consumed, the more carbon monoxide that enters which can cause more fat deposits so that the amount of oxygen that enters the heart decreases which will cause CHD (Rastogi et al., 2004).

The results showing a lack of association between CHD and smoking in this review are reported in two studies. In a study conducted in Guangzou, China, a review showed no difference between CHD patients with or without smoking habits (*p-value* > 0.05), possibly due to the limited sample size (Liu et al., 2022).

4. Body Mass Index

Obesity is simply defined as a condition of being overweight. Obesity is also defined as abnormal and excessive fat accumulation that can interfere with health which in practice is diagnosed based on Body Mass Index (BMI). Obesity increases the risk of cardiovascular disease through its influence on the development and severity of comorbidities such as hypertension, dyslipidemia, and glucose intolerance or diabetes (Canoy et al., 2013).

In this review, there were seventeen research articles discussing the relationship between body mass index and CHD events, where all articles reported a relationship between obesity body mass index and CHD events. One study conducted in Bangladesh showed that there was a relationship between body mass index and coronary heart disease in both men and women. This is evidenced by the value of p <0.05(Khan et al., 2015). The high prevalence of overweight American adults is associated with adverse effects on all of the major risk factors for CHD (Lamon-fava et al., 1996). Obesity shows an increased risk of 1.8 times to suffer from coronary heart disease (J. Lee et al., 2001). Compared to men with a BMI of 18.5 to 22.9 kg/m2, men with a BMI > 30.0 kg/m2 had a CHD risk of 1.81 (95% *CI*: 1.48 – 2.22). Among women, those with a BMI > 30.0 kg/m2 had a CHD risk of 2.16 (95% *CI*: 1.81 – 2.58) (Flint et al., 2011).

An increasing body mass index is associated with increasing cholesterol and triglyceride levels, lowering HDL cholesterol levels and increasing LDL cholesterol levels which can cause coronary heart disease. A person who is overweight or obese needs more blood to supply oxygen and food to the body's tissues, so that the circulating blood volume increases, cardiac output increases, and blood pressure also increases. In addition, obese people can increase the activity of the sympathetic nervous system and stimulate sodium retention in the kidneys, where when there is sodium retention and vasoconstriction, blood volume increases and blood pressure also increases. Obesity increases the risk of coronary heart disease, by increasing the burden of atherosclerotic plaque which is characterized by greater macrophage infiltration and plaque instability (Amato et al., 2020b)

However, the increase in various cardiovascular diseases can also occur in the absence of other co-morbidities and may be due to structural and functional changes of the myocardium through deposition of excess adipose tissue or through other mechanisms associated with obesity. Obesity increases the risk of coronary heart disease, by increasing the atherosclerotic plaque burden which is characterized by greater macrophage infiltration and plaque instability (Carbone et al., 2017).

CONCLUSIONS

Coronary heart disease is a pathological condition caused by atherosclerosis. Poor eating habits are associated with the risk of coronary heart disease through various processes. Excessive consumption of carbohydrates and fatty or cholesterol-rich foods can increase the risk of coronary heart disease. Fruits and vegetables contain fiber which when consumed in sufficient quantities is useful in reducing the risk of coronary heart disease. Adequate and regular physical activity can reduce the risk of coronary heart disease by burning body fat and calories, increasing cardiac output, and redistributing blood flow. Smoking behavior affects the body's oxygen levels, blood clots and calcification of blood vessel walls, as well as the effects of other substances from tobacco that make it difficult for the heart to work. Obesity increases the risk of coronary heart disease through its effect on high blood flow and so on.

Suggestion

Adopting a healthy lifestyle as an effort to prevent CHD by reducing excessive consumption of carbohydrates, fatty foods and high cholesterol, increasing consumption of fruits and vegetables, sufficient physical activity, not smoking and maintaining ideal body weight.

Reference

1) Al-zoughool, M. (2018). *Patterns of Physical Activity and the Risk of Coronary Heart Disease: A Pilot Study*. https://doi.org/10.3390/ijerph15040778

2) Amato, M., Bonomi, A., Laguzzi, F., Veglia, F., Tremoli, E., Werba, J. P., & Giroli, M. G. (2020a). Overall dietary variety and adherence to the Mediterranean diet show additive protective effects against coronary heart disease. *Nutrition, Metabolism and Cardiovascular Diseases*, *30*(8), 1315–1321.

3) Amato, M., Bonomi, A., Laguzzi, F., Veglia, F., Tremoli, E., Werba, J. P., & Giroli, M. G. (2020b). Overall dietary variety and adherence to the Mediterranean diet show additive protective effects against coronary heart disease. *Nutrition, Metabolism and Cardiovascular Diseases*, *30*(8), 1315–1321. https://doi.org/10.1016/j.numecd.2020.04.002

4) Bodkhe, S., Jajoo, S. U., Jajoo, U. N., Ingle, S., Gupta, S. S., & Taksande, B. A. (2019). Epidemiology of con fi rmed coronary heart disease among population older than 60 years in rural central India d a community-based cross- sectional study. *Indian Heart Journal*, *71*(1), 39–44. https://doi.org/10.1016/j.ihj.2019.01.002

5) Cannon, C. P., Granger, C. B., Hagström, E., Hochman, J. S., Koenig, W., Lonn, E., Nicolau, J. C., Steg, G., & Vedin, O. (2017). *Physical Activity and Mortality in Patients with Stable Coronary Heart Disease*. *70*(14). https://doi.org/10.1016/j.jacc.2017.08.017

6) Canoy, D., Cairns, B. J., Balkwill, A., Wright, F. L., Green, J., Reeves, G., & Beral, V. (2013). Body mass index and incident coronary heart disease in women: A population-based prospective study. *BMC Medicine*, *11*(1), 87. https://doi.org/10.1186/1741-7015-11-87

7) Carbone, S., Canada, J. M., Buckley, L. F., Trankle, C. R., Billingsley, H. E., Dixon, D. L., Mauro, A. G., Dessie, S., Kadariya, D., Mezzaroma, E., Buzzetti, R., Arena, R., Van Tassell, B. W., Toldo, S., & Abbate, A. (2017). Dietary Fat, Sugar Consumption, and Cardiorespiratory Fitness in Patients with Heart Failure with Preserved Ejection Fraction. *JACC: Basic to Translational Science*, *2*(5), 513–525. https://doi.org/10.1016/j.jacbts.2017.06.009

8) Chaeroni, A., Komaini, A., Pranoto, N. W., & Antoni, D. (2022). The Effect of Physical Activity Programs and School Environments on Movement Activities and Mental Health. *International Journal of Human Movement and Sports Sciences*, *10*(2), 131–137.

9) Chaeroni, A., Kusmaedi, N., Ma'mun, A., Budiana, D., & Haris, F. (2021). The Influence of the Learning Environment on Students' Physical and Mental Health Based on Gender. *International Journal of Human Movement and Sports Sciences*, *4*, 622–628.

10) Colditz, G. A., Rexrode, K. M., & Hu, F. B. (2011). *NIH Public Access*. *113*(4), 499–506. https://doi.org/10.1161/CIRCULATIONAHA.105.574087.Obesity

11) Damasceno, A. (2016). Noncommunicable disease. In S. Stewart, K. Sliwa, A. Mocumbi, A. Damasceno, & M. Ntsekhe (Eds.), *The Heart of Africa* (pp. 155–157). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119097136.part5

12) Flint, A. J., Rexrode, K. M., Hu, F. B., Glynn, R. J., Caspard, H., Manson, J. E., Willett, W. C., & Rimm, E. B. (2011). *NIH Public Access*. *4*(3), 1–18. https://doi.org/10.1016/j.orcp.2010.01.001.Body

13) Glynn, R. J., & Rosner, B. (2005). Comparison of Risk Factors for the Competing Risks of Coronary Heart Disease, Stroke, and Venous Thromboembolism. *American Journal of Epidemiology*, *162*(10), 975–982. https://doi.org/10.1093/aje/kwi309

14) Hicks, B., Veronesi, G., Ferrario, M. M., Forrest, H., Whitehead, M., Diderichsen, F., Tunstall-Pedoe, H., Kuulasmaa, K., Sans, S., Salomaa, V., Thorand, B., Peters, A., Soderberg, S., Cesana, G., Bobak, M., Iacoviello, L., Palmieri, L., Zeller, T., Blankenberg, S., & Kee, F. (2021). Roles of allostatic load, lifestyle and clinical risk factors in mediating the association between education and coronary heart disease risk in Europe. *Journal of Epidemiology and Community Health*, *75*(12), 1147–1154. https://doi.org/10.1136/jech-2020-215394

15) Hu, F. B., Rimm, E. B., Stampfer, M. J., Ascherio, A., Spiegelman, D., & Willett, W. C. (2000). *Prospective study of major dietary patterns and risk of coronary heart disease in men 1 – 3*. 912–921.

16) Ihsan, N., Amum, K. R., Rasyid, W., & Neldi, H. (2021). Development of information and technology-based learning media in athletic materials for short distance running numbers for quality junior n 2 students in Lubuk Linggau City, South Sumatra Province. *International Journal of Human Movement and Sports Sciences*, *9*(1), 124–129.

17) Investigation, O. (2001). *Dietary Patterns and the Risk of Coronary Heart Disease in Women*. *161*, 1857–1862.

18) Khan, R. J., Harvey, D. J., Leistikow, B. N., Haque, K. S., & Stewart, C. P. (2015). Relationship between obesity and coronary heart disease among urban Bangladeshi men and women. *Integrative Obesity and Diabetes*, *1*(3). https://doi.org/10.15761/IOD.1000112

19) Lamon-fava, S., Wilson, P. W. F., & Schaefer, E. J. (1996). *Impact of Body Mass Index on Coronary Heart Disease Risk Factors in Men and Women*.

20) Lang, T., Ducimetière, P., Arveiler, D., Amouyel, P., Cambou, J. P., Ruidavets, J. B., Montaye, M., Meyer, V., & Bingham, A. (1997). Incidence, case fatality, risk factors of acute coronary heart disease and occupational categories in men aged 30-59 in France. *International Journal of Epidemiology*, *26*(1), 47–57. https://doi.org/10.1093/ije/26.1.47

21) Lee, I., Rexrode, K. M., Cook, N. R., Manson, J. E., Buring, J. E., & Page, P. (2001). *Physical Activity and Coronary Heart Disease*. *285*(11), 1447–1454.

22) Lee, I., Sesso, H. D., Oguma, Y., & Paffenbarger, R. S. (2003). *Clinical Investigation and Reports Relative Intensity of Physical Activity and Risk of Coronary Heart Disease*. *02215*, 1110–1116. https://doi.org/10.1161/01.CIR.0000052626.63602.58

23) Lee, J., Heng, D., Chia, S., Chew, K., Tan, Y., & Hughes, K. (2001). *Risk factors and incident coronary heart disease in Chinese, Malay and Asian Indian males: The Singapore Cardiovascular Cohort Study*. 983–988.

24) Leening, M. J. G., Cook, N. R., Franco, O. H., Manson, J. E., Lakshminarayan, K., LaMonte, M. J., Leira, E. C., Robinson, J. G., Ridker, P. M., & Paynter, N. P. (2018). Comparison of Cardiovascular Risk Factors for Coronary Heart Disease and Stroke Type in Women. *Journal of the American Heart Association*, *7*(19). https://doi.org/10.1161/JAHA.117.007514

25) Leitzmann, M. F., Rimm, E. B., Stampfer, M. J., & Hu, F. B. (2002). *Exercise Type and Intensity in Relation to Coronary Heart Disease in Men*. *288*(16), 1994–2000.

26) Li, Y., Hruby, A., Bernstein, A. M., Ley, S. H., Rimm, E. B., Willett, W. C., & Frank, B. (2016). *Of Carbohydrates in Relation to Risk of Coronary Heart Disease : 66*(14), 1538–1548. https://doi.org/10.1016/j.jacc.2015.07.055.Saturated

27) Liu, X., Zhang, D., Wu, X., Tu, J., Gong, C., Li, Y., Cui, W., Chen, J., & Lu, S. (2022). Ecotoxicology and Environmental Safety Urinary metals as influencing factors of coronary heart disease among a population in Guangzhou, China. *Ecotoxicology and Environmental Safety*, *241*(May), 113746. https://doi.org/10.1016/j.ecoenv.2022.113746

28) Mmedsci, N. I. L., Agus, Z., Oenzil, F., Bmedsc, M. L. W., & Wattanapenpaiboon, N. (2004). *Dietary intake and the risk of coronary heart disease among the coconut-consuming Minangkabau in West Sumatra, Indonesia*. *13*(April), 377–384.

29) Oshunbade, A. A., Kassahun-, W., Valle, K. A., Hamid, A., Kipchumba, R. K., Kamimura, D., Iii, D. C., White, W. B., Defilippis, A. P., Blaha, M. J., Benjamin, E. J., Brien, E. C. O., Mentz, R. J., Rodriguez, C. J., Fox, E. R., Butler, J., Keith, R. J., Bhatnagar, A., Robertson, R. M., … Hall, M. E. (2021). *Cigarette Smoking, Incident Coronary Heart in Black Adults: The Jackson Heart Study*. https://doi.org/10.1161/JAHA.120.017320

30) Outcomes, M. (2018). *Association of Obesity or Weight Change with Coronary Heart Disease among Young Adults in South Korea*. *178*(8), 1060–1068. https://doi.org/10.1001/jamainternmed.2018.2310

31) Rastogi, T., Vaz, M., Spiegelman, D., Reddy, K. S., Bharathi, A. V, Stampfer, M. J., Willett, W. C., & Ascherio, A. (2004). *Physical activity and risk of coronary heart disease in India*. *33*(4), 759–767. https://doi.org/10.1093/ije/dyh042

32) Sesso, H. D., Paffenbarger, R. S., & Lee, I. (2000). *The Harvard Alumni Health Study*. *Lxxvi*.

33) Sieri, S., Agnoli, C., Grioni, S., Weiderpass, E., Mattiello, A., & Sluijs, I. (2020). Glycemic index, glycemic load, and risk of coronary heart disease: A pan-European cohort study. *The American Journal of Clinical Nutrition*, *112*(3), 631–643. https://doi.org/10.1093/ajcn/nqaa157

34) Smoke, S. (2020). *CORONARY HEART DISEASE* (Issue September).

35) Tayyem, R. F., Johannessen, A., Bawadi, H. A., Abumweis, S. S., Agraib, L. M., Allhedan, S. S., & Azab, M. (2017). Dietary patterns and the risk of coronary heart disease among Jordanians: A case – control study Nutrition, Metabolism & Cardiovascular Diseases Dietary patterns and the risk of coronary heart disease among Jordanians: A case e control study. *Nutrition, Metabolism and Cardiovascular Diseases*, *28*(3), 262–269. https://doi.org/10.1016/j.numecd.2017.10.026

36) Virani, S. S., Alonso, A., Aparicio, H. J., Benjamin, E. J., Bittencourt, M. S., Callaway, C. W., Carson, A. P., Chamberlain, A. M., Cheng, S., & Delling, F. N. (2021). *Heart disease and stroke statistics-2021 update: A report from the American Heart Association.*

37) Wan, Y. A. N. F., Ma, X. L. I., Yuan, C., Fei, L., Yang, J., & Zhang, J. U. N. (2015). *Impact of daily lifestyle on coronary heart disease*. 1115–1120. https://doi.org/10.3892/etm.2015.2646

38) Wang, C., Sun, Y., Jiang, D., Wang, C., & Liu, S. (2021). Risk-Attributable Burden of Ischemic Heart Disease in 137 Low- and Middle-Income Countries From 2000 to 2019. *Journal of the American Heart Association*, *10*(19), e021024. https://doi.org/10.1161/JAHA.121.021024

39) Weikert, C., Hoffmann, K., Dierkes, J., Zyriax, B., Klipstein-grobusch, K., Schulze, M. B., Jung, R., & Windler, E. (2005). *Nutritional Epidemiology A Homocysteine Metabolism – Related Dietary Pattern and the Risk of Coronary Heart Disease in Two Independent German Study Populations 1*. *February*, 1981–1988.

40) Welis, W., Darni, K., Rifki, M. S., & Chaeroni, A. (2022). Effect of Stunting Handling and Physical Activity on Motor Ability and Concentration of School Children. *International Journal of Human Movement and Sports Sciences*, *10*(5), 1040–1046.