Differences in Hemodynamic Status in Users of Tobacco Cigarettes and E-Cigarettes

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ABSTRACT

Background/Aim: The use of cigarettes is increasing every year, thus placing Indonesia in the first rank in ASEAN in the number of smokers. Cigarettes have many types, such as tobacco cigarettes and e-cigarettes. E-cigarettes are considered to be more 'healthy' than conventional cigarettes. Meanwhile, both tobacco cigarettes and e-cigarettes have the same content and mechanism that can have an effect on hemodynamic status. This study was performed to increase knowledge for further research regarding differences in hemodynamic status in users of tobacco cigarettes and users of electric cigarettes (e-cigarettes).

Methods: Based on the topic/subject, a literature search was conducted in the form of journals, textbooks through the Google Scholar, PubMed, and Cochrane databases. Which is determined from 2016 to 2021 and is indexed by Scopus, ISSN, national journals, and international journals.

Results: From the discussion of journals regarding research and theories about the effect of using tobacco cigarettes and e-cigarettes on hemodynamic status. There is no difference in hemodynamic status in the use of the two types of cigarettes because the content and mechanisms that affect the cardiovascular system are the same.

Conclusion: Based on the literature review, it can be concluded that there is no difference in hemodynamic status in the use of tobacco cigarettes and e-cigarettes.

Keywords: hemodynamic status, tobacco cigarettes, e-cigarettes.

INTRODUCTION

Tobacco use, especially cigarettes, is the leading cause of preventable premature death. Around 6 million people worldwide die from tobacco-related diseases every year. More than 80% of all smokers live in low-income and middle-income countries (LMICs). Globally, there is an increase in cigarette consumption, especially in developing countries. It is estimated that currently the number of smokers worldwide reaches 1.3 billion people. Although the dangers of smoking have been widely informed, the number of smokers globally has not decreased, in fact there is a tendency to increase every year. Approximately 90% of smokers start using tobacco before the age of 18, with nearly 100.[1]

Based on data from The Southeast Asia Tobacco Control Atlas (SEATCA) in 2018 it shows that globally there are more than 1.1 billion tobacco users with details of men amounting to 945 million while women amounting to 180 million. In the ASEAN region, there are 122 million adult smokers, and half of them live in Indonesia, namely 65,188,338 people.[2] Due to this, Indonesia is ranked third globally and first in ASEAN as the largest number of smokers. [3]

This is also supported by data that has been collected by the Tobacco Control Support Center by the Indonesian Association of Public Health Experts (TCSC IAKMI), namely national data stating that cigarette consumption among young smokers aged 10-18 years also increased by 1.9% in a period of 5 years (2013 – 2018), even a child has started smoking since elementary school age. This is because the price of cigarettes is cheap, can be bought in sticks, and there is no strict prohibition for children to buy cigarettes.[3]

Conventional cigarettes contain more than 7,000 chemicals, including nicotine, tar, and carbon monoxide, where these ingredients contribute to changes in hemodynamic status through endothelial damage mechanisms that will develop into cardiovascular disease.[4]. Cardiovascular disease is the leading cause of death and premature death in Indonesia, which is estimated to cause 558,736 deaths annually (36.3% of all deaths).[5]

Many smokers who want to quit their habit by looking for various ways to still be able to smoke but stay healthy so that the development of electric cigarettes (e-cigarettes).[6] Based on the data, e-cigarettes are growing rapidly among young people, especially students [6]. Globally in 2018 it is estimated that the prevalence of e-cigarette users in the middle and high school age group is 4 million people.[7] In the national scope, the national average prevalence of e-cigarette use is 2.8%. [3]. The trusted benefits when using e-cigarettes are that it helps smokers to quit smoking and is safe for health, so that people switch from conventional cigarettes to e-cigarettes.[6]

E-cigarettes contain diacetyl, propylene glycol, glycerin, and nicotine. Nicotine content that can cause changes in hemodynamic status. Although e-liquid does not contain nicotine, other substances resulting from heating from e-cigarettes can also affect hemodynamic status.[6]

Actually, both conventional cigarettes and e-cigarettes, both can affect health. One of them can affect the cardiovascular system. Smoking can increase blood pressure in normotensive and hypertensive individuals, besides that it can increase heart rate, vascular resistance, and catecholamines in the systemic circulation.[8,9]

Due to the adverse effects caused by the use of conventional cigarettes and electric cigarettes, the Tarjih Council and Tajdid Muhammadiyah issued a fatwa that the use of both cigarettes is unlawful. This is based on the fact that smoking is included in the category of khabā'iṡ (damaging/harmful) actions which are prohibited in Q. 7: 157. In addition, smoking contains elements of throwing oneself into destruction and even is an act of suicide quickly or slowly so that because of it is against the prohibition of the Qur'an in Q.2:195 and 4:29.[10]

Based on the description above, it can be concluded that both conventional cigarettes and e-cigarettes can cause various problems in an individual's body, one example is the cardiovascular system which can increase blood pressure. Assessment of the cardiovascular system can be done by monitoring a person's hemodynamic status. Hemodynamic components can be checked by looking at the Mean Arterial Pressure (MAP) and heart rate. Therefore, the authors are interested in conducting an analysis of differences in hemodynamic status in users of conventional cigarettes and e-cigarettes as a description of cardiovascular system disorders. The review is carried out by collecting journals and books obtained from the internet, then read and analyzed for later discussion in this literature review.

METHOD

Literature Search Design in the form of journals and textbooks using google chrome on the NCBI Pubmed site (https://pubmed.ncbi.nlm.nih.gov/), Cochrane, and using Google Scholar (https://scholar.google.co.id/). The keywords used include hemodynamic status, conventional cigarettes, e-cigarettes. The

limitations of journals are those published in the last 5 years and according to the topics raised that meet criteria such as being indexed by Scopus, ISSN, national journals or international journals.

Based on the literature search design, 34 journals and textbooks were obtained with details of 24 Q1 indexed journals, 8 Q2 indexed journals, 1 Copernicus Value indexed journal, 1 S1 indexed journal at Sinta Indonesia, and 5 textbooks that became the basis for writing.

RESULT AND DISCUSSION

The use of conventional cigarettes and e-cigarettes is increasing every year. The most common age prevalence of conventional cigarette users in Indonesia is the elderly age group of 45-64 years which shows 40% results, followed by the 25-44 year age group and over 65 years which shows 38% results.[11]

Apart from the use of conventional cigarettes, the use of e-cigarettes shows an increasing trend among young people. E-cigarettes begin to be used at middle school age (13-15 years) to high school (15-18 years), as shown by a cross-sectional study conducted by Cullen et al in 2019, it was found that the prevalence of e-cigarette use among students has increased and most of them are exclusive users (only use e-cigarettes).[7] The main reason that teenagers use e-cigarettes is because there are many kinds of flavorings that attract attention in e-liquid so they want to try and develop into regular users of e-cigarettes.[12]

The use of conventional cigarettes and e-cigarettes is overall about twice as common in men than women.[1]This was also conveyed by the GATS (Global Adult Tobacco Survey) issued by the CDC in 2015 showing that tobacco use rates remain high, especially for men, according to a survey conducted over the last decade, in which nearly two out of three adult males smoke. So that the sex distribution of conventional and e-cigarette users is more male than female.[11]

The use of conventional cigarettes and e-cigarettes can affect a person's hemodynamic status, it has been proven, cigarette consumption can cause injury to the cardiovascular system through mechanisms such as inflammation, coagulation, and oxidative stress.[13]

To determine the hemodynamic status of an individual we can monitor and assess the functions of the cardiovascular system, such as blood pressure and heart rate.[14]If the heart rate and systolic and diastolic pressures increase, this means that they also have an effect on increasing the Mean Arterial Pressure (MAP). MAP is the average of arterial pressure over the entire cardiac cycle, which is calculated as diastolic pressure plus one third of pulse pressure, so that MAP is directly proportional to cardiac output. MAP classification can be used to see the relationship of blood pressure with risks such as hypertension, stroke, cardiovascular disease, and others, so that MAP can be effectively used for monitoring a person's hemodynamic status.[15]

The increase in hemodynamics can occur, one of which is due to an individual's lifestyle, such as smoking.[16] Smoking is to put smoke from burning cigarettes into the mouth which then goes into the lungs. [17] In general, smoking is one of the most significant risk factors for improving hemodynamic status.[16]

In a study conducted by Kondo et al in 2019, it was found that active and passive tobacco smoking can increase the incidence in all phases of atherosclerosis starting from endothelial dysfunction to hemodynamic disorders that can cause CVD due to the chemical content of more than 7,000 chemicals including nicotine, tar, and carbon monoxide. These compounds contribute to the development of hemodynamic disturbances through increased heart rate, myocardial contractility, inflammation, endothelial dysfunction, thrombus formation, and decreased serum high-density lipoprotein cholesterol levels. Not only that, the use of

conventional cigarettes can also increase blood pressure acutely through sympathetic nerve activation even with just 1 cigarette.[4]The use of conventional cigarettes can cause hemodynamic disturbances which are characterized by an increased risk of CVD. This is also supported by the results of a systematic review and meta-analysis by Hackshaw et al in 2017 which showed that smoking as much as one cigarette per day carries the risk of coronary heart disease and stroke, which are included in clinical conditions that affect hemodynamic status with details in men relative risk. for coronary heart disease were 1.48 for smoking one cigarette per day and 2.04 for 20 cigarettes per day, while in women the aggregated relative risks were 1.57 and 2.84 for one and 20 cigarettes per day, respectively. For stroke, the relative risk for men was 1.25 for smoking one cigarette and 1.64 for 20 cigarettes per day, whereas for women, the relative risk for stroke was 1. 31 for smoking one cigarette and 2.16 for 20 cigarettes per day. So it can be said that there is no safe level of smoking.[18]

Cigarettes have many types and forms such as conventional cigarettes or e-cigarettes.[16] The constituents or content found in both conventional cigarettes and e-cigarettes that can cause hemodynamic disturbances are nicotine and toxic organic chemical compounds (acrolein, formaldehyde, and acetaldehyde).[19]

The effect of nicotine on conventional cigarette use can reduce the expression of Sirt3. Sirt 3 is key in the regulation of mitochondrial function. Sirt3 activates mitochondrial metabolism by deacetylating tricarboxylic acid cycle enzymes and fatty acid oxidation enzymes as well as maintaining mitochondrial NADPH (Nicotinamide Adenine Dinucleotide Phosphate) status and activating SOD2. Sirt3 can increase SOD2 to become hyperacetylated thereby increasing mitochondrial O2- and causing cardiolipin oxidation which in turn contributes to impaired vascular relaxation,

causing hemodynamic disturbances. Not only that, the effect of nicotine causes depletion of Sirt3 so that it can increase vascular oxidative stress and ultimately lead to an increase in hemodynamic status such as hypertension.[8]

Changes in hemodynamic status due to the content of nicotine in conventional cigarettes are also supported by the results of research conducted by Arastoo et al in 2020 showing that there has been an increase in hemodynamics which is highly correlated with the increase in plasma nicotine in the research object, namely users of conventional cigarettes.[20]

Not only the use of conventional cigarettes can affect hemodynamic status, the use of e-cigarettes can also improve hemodynamic status. In a study conducted by Phoebe D. Garcia in 2020 showed that the use of e-cigarettes can increase blood pressure, both systolic pressure and diastolic pressure and heart rate. This hemodynamic improvement is due to the sympathoexcitatory effect of vaping e-cigarettes containing nicotine.[21] This is also in line with research conducted by Franzen et al in 2018 to 15 young people who did not use e-cigarettes which showed that the group using e-cigarettes with nicotine experienced a significant increase in blood pressure and heart rate compared to the group using e-cigarettes. no nicotine.[16]

Research by Moheimani et al, 2017 was conducted on 33 healthy non-smokers and compared between the e-cigarette group with nicotine and the e-cigarette group without nicotine. The results showed an acute increase in the sympathomimetic effect that correlated with the use of e-cigarettes with nicotine. An increase in the form of systolic and diastolic blood pressure and MAP which causes an increase in hemodynamic status which will continue to be a risk for CVD.[22]The effect on hemodynamics after the use of e-cigarettes was also mentioned in a study conducted by Skotsimara et al in 2019 in a systematic review and meta-analysis which stated that

there was an increase in blood pressure and heart rate after using e-cigarettes. The acute effects of e-cigarettes on hemodynamics can be caused by the nicotine contained in e-cigarettes, which binds to nicotinic cholinergic receptors located in the brain, autonomic ganglia, adrenals, and neuromuscular junctions, and increases the release of various neurotransmitters, including epinephrine, norepinephrine, dopamine, serotonin. , and vasopressin.[23]

NiCotine is a highly addictive drug that has wide-ranging effects on the central nervous system (CNS). It acts on nicotinic acetylcholine receptors (nAChRs), ligand-gated ion channels whose endogenous neurotransmitter is acetylcholine (ACh). The influence of nicotine reaches the Nucleus Tractus Solitary (NTS) which works as the center of the human cardiovascular system located in the hindbrain[24]. Initially nicotine will be absorbed through the mouth and throat and will enter the pulmonary venous circulation, then enter the arterial circulation and travel to the brain through the blood-brain barrier. Nicotine will bind to the nAChRs receptor causing a conformational change. Sodium ions (Na+) will enter the cell through the middle pore in the nAChR and will cause ion exchange, so that calcium ions (Ca2+) enter the cell and cause depolarization. Depolarization stimulates exocytosis of norepinephrine stores. Norepinephrine binds to 1 adrenergic receptors on the surface of smooth muscle cells, thereby stimulating the influx of calcium ions and the release of stored calcium. In addition, norepinephrine also binds to 2 adrenergic receptors on the surface of smooth muscle cells causing inhibition of adenylate activity.[25]

Nicotine is a sympathomimetic drug that acts on nicotinic receptors located throughout the autonomic nervous system to increase sympathetic nervous and catecholamine release. Thus, it is not surprising that acute exposure to cigarettes with nicotine can increase the sympathetic nervous system.[22]An increased sympathetic nervous system will activate 1-adrenergic receptors in blood vessels and 1-adrenergic receptors in the heart which causes an increase in cardiac contractility. The increased cardiac contraction results in an increase in stroke volume as well. An increase in stroke volume and cardiac contractility causes an increase in cardiac output which in turn results in an increase in blood pressure.[26,27]

Increased sympathetic nerves due to nicotine use can also stimulate the splenocardiac axis. This was conveyed in a study conducted by Boas et al in 2017 which stated that during acute stress after nicotine exposure, there will be an increase in central sympathetic flow and will activate bone marrow progenitor cells and leukocytes through stimulation of b-3 receptors. Leukocyte progenitor cells migrate from the bone marrow to the spleen, where they multiply in response to stem cell factors. The increased number of proinflammatory monocytes then leaves the spleen to enter the circulation, reaching the arterial walls where increased monocyte recruitment promotes and accelerates atherosclerosis which is a risk factor for hemodynamic compromise. Not just a temporary process, detectable proinflammatory changes in the vessel wall have been found to persist for months. Although the carcinogenic toxins present in the aerosols produced by e-cigarettes are much lower than those in conventional cigarette smoke, the nicotine levels achieved by exposure to the two types of cigarettes are no different.[28]

In addition to nicotine, the result of burning conventional cigarettes or heating e-cigarettes is acetaldehyde, formaldehyde, and acrolein which can affect hemodynamic status.[29]As stated by Henning et al in 2017, in their research that acrolein can react with proteases so as to trigger oxidative stress and inflammatory responses in cardiovascular tissue. Chronic exposure to acrolein can cause myocyte dysfunction, myocyte necrosis and apoptosis and eventually lead to cardiomyopathy and heart

failure leading to hemodynamic disturbances.[30]

Not only nicotine and smoke from cigarettes can affect hemodynamic status. Flavors contained in e-cigarettes can also affect hemodynamic status. This is in line with research from Fetterman et al in 2018, it was found that the use of deep flavors such as e-cigarettes in the short term resulted in endothelial cell dysfunction, characterized by increased oxidative stress, loss of nitric oxide signaling, increased expression of proinflammatory mediators, namely IL-6 (interleukin). -6), oxidative stress, and prothrombotic phenotype. Meanwhile, endothelium plays an important role in maintaining vascular homeostasis, which has been shown to increase the risk of hemodynamic disturbances if disturbed.[31] From a study conducted by Caporale et al in 2019 on 31 healthy non-smokers, it also showed that inhaling an aerosol of e-cigarettes without nicotine can have a temporary impact on endothelial function in healthy non-smokers, not only that, the results showed an increase in blood flow velocity and increased blood flow. oxygenation of the superficial femoral artery and vein, even if it occurs acutely if it is not treated, will have long-term, potentially detrimental effects on vascular health.[32] So that with nicotine and/or without nicotine in e-cigarettes, it can also change a person's hemodynamic status.[21]

Many people think that the use of e-cigarettes can be useful for efforts to stop smoking from conventional cigarettes. In the study of Hajek et al, 2019 which compared the effectiveness of using e-cigarettes compared to other nicotine replacement therapies for overcoming addiction from cigarettes, it showed that e-cigarettes were 18% more effective compared to the results of nicotine replacement therapy which was 9.9% in an effort to quit smoking. However, the e-cigarette group experienced throat, mouth irritation, and serious respiratory side effects compared to the therapeutic group using e-cigarettes.[33]

Research conducted by Rhoades et al in 2019 to American Indians showed that in multiple users (using conventional cigarettes and e-cigarettes) the level of dependence to continue using cigarettes was greater for conventional cigarettes compared to e-cigarettes by 76% of the research object. However, the use of e-cigarettes can allow an increase in nicotine delivery in the body when using different generations of e-cigarettes.[34] Similarly, what Benowitz and Fraiman reported in 2018 showed that next-generation devices usually have larger batteries, resulting in larger amounts of aerosols and a much higher dose of nicotine than first-generation devices. In addition, it was found that the cardiovascular risk was smaller in the use of e-cigarettes than conventional cigarettes because of their more complex content. However, although the relative level of harm caused by e-cigarettes is lower than that of conventional cigarettes, the possible adverse effects of using regular e-cigarettes cannot be ruled out because their actual content is the same as conventional cigarettes.[29]

CONCLUSION

Both users of conventional cigarettes and e-cigarettes showed a higher prevalence of males than females with an age distribution indicating advanced adulthood (45-64 years) in conventional cigarette users and adolescents in e-cigarette users. The effect of using conventional cigarettes and e-cigarettes shows the same thing, namely the use of both cigarettes can cause an increase in sympathetic nerves and oxidative stress that affects the endothelium, causing an increase in hemodynamic status.

The most influential content of changes in hemodynamic status in both types of cigarettes is nicotine. The effect of conventional cigarettes is greater on hemodynamic status than e-cigarettes. The detrimental effects of using regular e-cigarettes cannot be ruled out because they contain the same ingredients as conventional cigarettes.

Suggestions are needed for further research and studies related to the effect of nicotine in conventional cigarettes and e-cigarettes on hemodynamics, with previously carried out laboratory tests for plasma cotinine content so that there are no confounding variables and so that the nicotine levels contained are similar between the two types of cigarettes. Research and study on the chronic effects of vaping nicotine containing or nicotine-free liquids on peripheral and central blood pressure.

Conflict Of Interest

There are no conflicts of interest to declare by any of the authors of this study.

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