Research Article

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Investigating the Correlation between Dietary Fiber Intake and Cardiovascular Disease Morbidity

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Abstract

The main objective of this study is to statistically examine the relationship between the average intake of dietary fiber in the adult population in R. North Macedonia and morbidity from cardiovascular diseases. The research covers the period from January 1, 2017 to December 31, 2022. The data we used to conduct the research came from the Public Health Institute of R. North Macedonia. Pearson's correlation coefficient was used as a statistical method for data processing. The average daily intake of dietary fiber among the adult population in R. North Macedonia is 20.75 g, which is below the recommendations of 36 g/day for men and 25 g/day for women. There is a low correlation ($r = 0.22$) between the average daily intake of dietary fiber in the adult population and the morbidity rate of circulatory diseases (rate per 100,000 inhabitants) at the primary health care level, while between the average daily intake of dietary fiber in the adult population and hospital morbidity from circulatory diseases (rate per 100,000 inhabitants), there is a weak correlation ($r = 0.11$). Such results are primarily due to the fact that other risk factors influence the occurrence of cardiovascular diseases: tobacco use, physical inactivity, an improper diet, excessive alcohol use, etc. From this study, it can be concluded that the intake of dietary fiber should be increased among the adult population, which is necessary for a healthy and balanced diet because it protects us from cardiovascular.

Keywords: Fiber, Morbidity, CVD, Correlation, Nutrition

Introduction

According to WHO data, in 2016, cardiovascular diseases were the cause of death for 17.8 million people worldwide, or 31.4% of all deaths. Of this number, 85% of deaths are attributable to ischemic heart disease and stroke, which are the leading causes of death in the world [1]. Despite progress in the protection of cardiovascular health in developed countries, cardiovascular diseases are still one of the main causes of death in developing countries, but this can be reduced if, from early childhood, the prevention of atherosclerotic cardiovascular diseases is a public health priority [2].

Cardiovascular diseases are the result of complex interactions between genetic and environmental factors over a long period of time. The most significant factors that can affect the worsening of cardiovascular diseases are bad nutritional habits during childhood and adolescence hyperlipidemia, where especially the intake of saturated fats should be reduced smoking that increases the risk of developing CVD and death by 2 times, regardless of the type of cigarette and the way of smoking obesity that is the cause of the appearance of many diseases physical inactivity is a key problem

in all CVD prevention strategies, it has been proven that 1 hour of physical activity compensates for 8 hours of sitting [3-7]. Therefore, the high mortality from cardiovascular diseases shows discovery and poor control of the mentioned risk factors [8].

So, a healthy, balanced, varied, harmless, and protective diet plays a major role in reducing atherosclerosis and arterial hypertension and, thus, in the development of CVD. Numerous studies have shown that if cardioprotective nutrients are well included in the diet plan, they significantly reduce the risk of CVD [9, 10].

In some studies, increasing the inclusion of dietary fiber in human nutrition has given good results for cardiovascular diseases. They are components of plant origin that are not completely digested in the human intestines and are divided into soluble and insoluble. Insoluble fibers include cellulose, lignin, and hemicelluloses such as arabinoxylan and glucomannan, while soluble fibers include pectin's, cereal β-glucans, hydrocolloids such as gums (e.g., guar or mannan), and mucilages (including psyllium) [11]. In their study, Ignarro et al. proved that increasing the intake of soluble dietary fiber significantly reduces the risk of obesity, blood pressure, cholesterol, triglycerides, and homocysteine, which

are prerequisites for the occurrence of cardiovascular diseases [12]. Pectin is a type of vegetable fiber that was discovered to lower blood cholesterol concentrations almost half a century ago [13]. Pectin also acts to lower LDL cholesterol, while HDL cholesterol and triglycerides do not change significantly due to their influence. β-glucans are substances found in abundance in oats and significantly reduce the amount of total cholesterol and LDL [4]. Therefore, different mechanisms present and explain the apparent protective effects of dietary fiber on the cardiovascular system, such as changes in cholesterol absorption and reabsorption of bile acids and changes in the production of lipoproteins in the liver. All this leads to a decrease in LDL cholesterol and circulating triglycerides [14].

According to the Institute for Public Health, there are two main approaches to preventing the incidence of CVD: targeting the general population and targeting people at increased risk [15].

The aim of this research is to statistically investigate the relationship between the average intake of dietary fiber in the adult population in the Republic of North Macedonia and morbidity from cardiovascular diseases.

Materials and Methods

Research Material
The main focus of this scientific study is to determine the statistical correlation between the average intake of dietary fiber in the elderly population in the Republic of North Macedonia and morbidity from cardiovascular disease. The research was carried out by the Faculties of food technology and nutrition at the University of Tetova, the VT diet club in Bitola, and the Public Health Institute of the Republic of North Macedonia (Skopje). The investigation covers the period from January 1, 2017 until December 31, 2022. The data we used to conduct this research were obtained from the Department of Nutrition and Health and Hygiene Inspection at the Institute of Public Health of the Republic of Northern Macedonia, as well as from the publication "Circulatory Disease Status in the Republic of North Macedonia 2022" issued by the Institute for Public Health in the Republic of North Macedonia. The research is of the retrospective type.

Research Methodology

To conduct this research, it was important to meet certain criteria:
- determine the average daily intake of dietary fiber among the adult population in the Republic of North Macedonia in the period 2017–2022;

- to determine the rate of morbidity from circulatory diseases (rate per 100,000 inhabitants) at the level of primary health care in the Republic of North Macedonia in the period 2017–2022;
- to determine the rate of hospital morbidity from circulatory diseases (rate per 100,000 inhabitants) in the Republic of North Macedonia in the period 2017–2022.

Statistical Method
Pearson's correlation coefficient was used as a statistical method. The data is shown in tabular form.

Results and Discussion
With correlation, we examine the relationship between the mutual changes of two or more phenomena. In medicine, there is no strict mathematical relationship with mass phenomena; that is, it is not possible to completely remove the action of random factors from the action of the "main" factor. It could be said that correlation in medicine examines the relationship between the influence and interdependence of changes in two or more phenomena. In the series with numerical marks, by examining the relationship, it is seen how the changes in the average values of one phenomenon affect the changes in the average values of other phenomena. Correlation can be simple, multiple, linear, or curvilinear. The value and strength of the correlation are determined by Pearson's correlation coefficient (r). The correlation coefficient varies from -1 to +1. The closer the value of the correlation coefficient is to 1, the stronger the correlation. If r = 0, then correlation does not exist.

Table 1 shows the methodology for determining a simple linear correlation. The correlation coefficient was determined by the formula:

$$r = \frac{Cxy}{\delta x \times \delta y}$$

In the formula C is covariance, x shows one (dependent) and y shows the other (independent) phenomenon. δ represents the standard deviation. The covariance C was determined by the formula:

$$Cxy = \frac{\sum xy}{N} - \bar{x} \times \bar{y}$$

Table 1: Examination of the Relationship between the Average Daily Intake of Dietary Fiber in the Adult Population and the Morbidity rate of Circulatory Diseases (Rate Per 100,000 Inhabitants) at the Level of Primary Health Care, Republic of North Macedonia in the Period 2017–2022

Year	Average dietary fiber intake in the adult population (g) x	d(x)=(x-x̄)	d(x)*d(x)= (x-x̄) *(x-x̄)	Mb (rate per 100,000) y	d(y)=(y-ȳ)	d(y)*d(y)= (y-ȳ) *(y-ȳ)	x*y
2017	20.6	-0.15	0.0225	39.676	1.1135	1.2398823	817.3256
2018	20	-0.75	0.5625	43.028	4.4655	19.94069	860.56
2019	23.7	2.95	8.7025	42.645	4.0825	16.666806	1010.687
2020	21	0.25	0.0625	31.03	-7.5325	56.738556	651.63
2021	20.5	-0.25	0.0625	36.939	-1.6235	2.6357523	757.2495
2022	18.7	-2.05	4.2025	38.057	-0.5055	0.2555302	711.6659
Σ	124.5		13.615	231.375		97.477218	4809.118
X̄	20.75			Ȳ 38.5625			

First, the average values of the daily intake of dietary fiber in the adult population ($\overline{X}$=20.75 g) and the morbidity rate from circulatory diseases (rate per 100,000 inhabitants) at the level of primary health care ($\overline{Y}$=38.56) are determined. Determining the standard deviation of the two occurrences is the next step in the process.

$$\delta x = \sqrt{\frac{\sum d^2}{N}} = \sqrt{\frac{13,615}{6}} = 1,51$$

$$\delta y = \sqrt{\frac{\sum d^2}{N}} = \sqrt{\frac{97,477218}{6}} = 4,03$$

The value of the standard deviation in the daily intake of dietary fiber in the adult population is δx=1.51, while in the rate of morbidity from circulatory diseases (rate per 100,000 inhabitants) at the level of primary health care, it is δy=4.03. The individual products between the values of the daily intake of dietary fiber in the adult population and the morbidity rate of circulatory diseases (rate per 100,000 inhabitants) at the level of primary health care and their sum ∑4809.118 are determined. The obtained values from Table 1 are substituted into the covariance formula:

$$xy = \frac{\sum xy}{N} - \bar{x} \times \bar{y} = \frac{4809,118}{6} - 20,75 \times 38,5625 = 801,52 - 800,17 = \mathbf{1,35}$$

The covariance value is Cxy = 1.35. If the values are replaced in the formula for creating the correlation coefficient, we get:

$$r = \frac{Cxy}{\delta x \times \delta y} = \frac{1,35}{1,51 \times 4,03} = \frac{1,35}{6,0853} = \mathbf{0,22}$$

The average daily intake of dietary fiber in the adult population and the morbidity rate of circulatory diseases (rate per 100,000 inhabitants) at the level of primary health care during the 6-year period under study have a low correlation, according to the obtained value of the correlation coefficient, r = 0.22.

Table 2 shows the examination of the relationship between the average daily intake of dietary fiber in the adult population and hospital morbidity (rate per 100,000 inhabitants) from circulatory diseases in the Republic of North Macedonia in the period 2017–2022.

Table 2: Examination of the Relationship between Average Daily Intake of Dietary Fiber in the Adult Population and Hospital Morbidity (Rate Per 100,000 Inhabitants) from Circulatory Diseases, R. of North Macedonia, 2017-2022

Year	Average dietary fiber intake in the adult population (g) x	d(x)=(x-x̄)	d(x)*d(x)= (x-x̄) *(x-x̄)	Mb (rate per 100,000) y	d(y)=(y-ȳ)	d(y)*d(y)= (y-ȳ) *(y-ȳ)	x*y
2017	20.6	-0.15	0.0225	1.717	0.1805	0.0325803	35.3702
2018	20	-0.75	0.5625	1.687	0.1505	0.0226503	33.74
2019	23.7	2.95	8.7025	1.756	0.2195	0.0481802	41.6172
2020	21	0.25	0.0625	1.182	-0.3545	0.1256703	24.822
2021	20.5	-0.25	0.0625	1.198	-0.3385	0.1145823	24.559
2022	18.7	-2.05	4.2025	1.679	0.1425	0.0203063	31.3973
∑	124.5		13.615	9.219		0.3639695	191.5057
X̄	20.75		Ȳ	1.5365			

The average value of the daily intake of dietary fiber in the adult population is $\overline{X}$=20.75 g, while the average value of hospital morbidity from circulatory diseases (rate per 100,000 inhabitants) is $\overline{Y}$=1.54. The next step is to determine the standard deviation of hospital morbidity from circulatory diseases (rate per 100,000 inhabitants):

$$\delta y = \sqrt{\frac{\sum d^2}{N}} = \sqrt{\frac{0,3639695}{6}} = 0,25$$

The value of the standard deviation in the daily intake of dietary fiber in the adult population is δx=1.51, while in hospital morbidity from circulatory diseases (rate per 100,000 inhabitants) is δy=0.25. The individual products between the values of the daily intake of dietary fiber in the adult population and the hospital morbidity (rate per 100,000 inhabitants) from circulatory diseases and their sum ∑191.5057 are determined. The obtained values from Table 2 are substituted into the covariance formula:

$$Cxy = \frac{\sum xy}{N} - \bar{x} \times \bar{y} = \frac{191,5057}{6} - 20,75 \times 1,5365 = 31,92 - 31,88 = 0,04$$

The covariance value is Cxy = 0.04. If the values are replaced in the formula for creating the correlation coefficient, we get:

$$r = \frac{Cxy}{\delta x \times \delta y} = \frac{0,04}{1,51 \times 0,25} = \frac{0,04}{0,3775} = \mathbf{0,11}$$

Based on the obtained value of the correlation coefficient r = 0.11, it can be said that between the average daily intake of dietary fiber in the adult population and hospital morbidity (rate per 100,000 inhabitants) from circulatory diseases in the investigated 6-year period, there is a weak correlation [16,17].

According to Memeti, the most common behavioral risk factors for cardiovascular disease are tobacco use, physical inactivity, poor diet, and excessive alcohol use, leading to four key metabolic-physiological changes: high blood pressure, obesity, increased blood sugar, and elevated cholesterol [18]. Also, the risk increases with age and is higher in women than in men.

In the middle of the last century, when mass food processing began, it was thought that dietary fiber was a useless and unnecessary part of plant food because it had no energy value. But later, when science showed that it was not true that dietary fiber was unnecessary but, on the contrary, that it was one of the most important components of food, the food industry began to play a different game. That is, since then, the sale of fiber supplements in refined products has continued, which, according to Dr. Biban, is not good because, in such a form, they cannot respond to the needs of the organism [19].

Scientific studies conducted on adults with cardiovascular disease indicate that increased intake of dietary fiber leads to a reduction in total cholesterol (mean difference, MD - 0.42 mmol/L) and LDL cholesterol (MD - 0.47 mmol/L). Also, scientific studies conducted on adults suffering from hypertension show that increased intake of dietary fiber reduces systolic (MD – 4.3 mmHg) and diastolic (MD – 3.1 mmHg) blood pressure. These benefits were recorded regardless of cardioprotective drug use [20]. Meta-analyses indicate statistically significant reductions in the relative risk (RR) of mortality from cardiovascular disease (RR = 0.77–0.83), as well as the incidence of cardiovascular disease (RR = 0.72-0.91), coronary heart disease (RR = 0.76–0.93), and stroke (RR = 0.83–0.93) [21].

It is concerning that the average daily dietary fiber intake of the adult population in the Republic of North Macedonia in the period 2017-2022 is 20.75 g, which is less than the recommendations of 36 g/day for men and 25 g/day for women [22]. Furthermore, the findings of our study indicate that, based on the obtained value of the correlation coefficient r = 0.22, there is a low correlation between the average daily intake of dietary fiber in the adult population and the morbidity rate of circulatory diseases (rate per 100,000 inhabitants) at the primary health care level during the examined period 2017-2022. Based on the obtained correlation coefficient r = 0.11, it is possible to conclude that there is a weak correlation between the average daily intake of dietary fiber in the adult population and hospital morbidity (rate per 100,000 inhabitants) from circulatory diseases during the study period 2017-2022.

Such results are mostly attributable to the fact that the occurrence of cardiovascular illnesses is impacted by other risk factors such as tobacco use, physical inactivity, an unhealthy diet, excessive alcohol use, and others. However, one of the primary risk factors leading to the incidence of cardiovascular illnesses in our nation is the adult population's low average daily intake of dietary fiber, which may be successfully regulated in order to avoid the occurrence of cardiovascular disease. Spiroski found that only older urban men consumed more dietary fiber (p = 0.030) [23]. In the conclusion of their study, it is emphasized that macronutrient intake should be improved in adults, especially dietary fiber, in order to stimulate a healthier diet for the prevention of non-communicable diseases.

Conclusion

Until recently, it was thought that dietary fiber was excreted in the feces and that these carbohydrates were not important because they were not a source of energy. But recent discoveries show us the great importance of seemingly useless fibers: they serve as intestinal cleaners, absorbing all poisons and removing harmful substances, such as bile acids that precede cholesterol. Dietary fibers are exclusively of plant origin, so if we do not consume enough grains, vegetables, and other plant foods, we will have problems with cholesterol levels, constipation, blood sugar levels, obesity, etc.

In our study, it was proven that the intake of dietary fibers is low in adults and that the correlation coefficient between the daily intake of the adult population and the morbidity rate for the primary health level, as well as for the hospitalized morbidity, is low. However, cardiovascular diseases are also affected by other risk factors, such as tobacco use, physical inactivity, an improper diet, and excessive alcohol use. Also, the low intake of dietary fiber is a factor that contributes to the increase in the occurrence of cardiovascular diseases and morbidity.

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