

Original article:

The Body Mass Index (BMI) of Human Age and Gender Structure as the Main Cause of Cardiovascular and Nephrotic Diseases

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Abstract

Background: Factors affecting the growth of the organism may be either endogenous, such as genetic factors like genetic heritage, or exogenous such as food, social and health status, physical activity, etc. A factor of great importance for human physical growth is BMI, a parameter defined as the ratio of human body weight and height. **Aims:** The purpose of this article is to determine the BMI in Macedonia's population by analyzing age and gender, and finding the correlation of endogeneous and exogeneous factors and the BMI factor. All measurements were performed at the health facility. Surveys were also conducted for gathering information about gender, age, weight, height, eating habits, socio-economic status, and education. **Results:** This clinical research studied 257 patients, 143 males and 114 females. Among other factors involved in this research are blood glucose, fat parameters and potential risk factors for cardiovascular and nephrotic diseases. **Conclusions:** After the discovery and identification of renal disease, the impact of BMI can be distinguished from pathological processes, such as irregular eating, various inflammations, and changes in the metabolism of vitamin D, etc.

Keywords: BMI, endogenous and exogenous factors, cardiovascular and nephrotic diseases.

Introduction

During recent years, the prevalence of chronic renal disease has grown significantly and is expected to double continually every 8 to 10 years¹. Massive growth rates of obesity, diabetes and hypertension will also encourage the dramatic increase of renal disease². Besides the direct cost of treating patients in all stages of chronic renal disease (special drugs, kidney transplantation), high risk of developing cardiovascular disease represents the main cause of morbidity and mortality to human population³. The risk of mortality from cardiac complications is 65 times higher in patients

with dialysis between the ages of 45-54 years and 500 times higher than among healthy people⁴. Other studies show that this increase in cardiovascular risk begins very early in patients with renal disease. About one third of patients with damaged kidneys (glomerular filtration < 50 ml) have been diagnosed with cardiovascular disease⁵, it is understood that it is important to detect the pathophysiology of cardiovascular diseases to chronic renal disease to effectively protect the heart and thus extend the life of patients with renal impairment. High blood pressure causes more than 25.000 new cases of kidney damage in the U.S⁶. The American

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National Heart, Lung, and Blood Institute (NHLBI) recommends five potential parameters that help control blood pressure, among the most important is a BMI with an average value of 18.5–25 kg/m².

Aims of research

The purpose of this paper is to determine the correlation between BMI and risk factors for cardiovascular and nephrotic disease in different age human groups. To achieve this aim, the following goals are pursued:

To collection data and parameters for potential factors for cardiovascular and nephrotic disease;

To compare the potential parameters of risk for cardiovascular and nephrotic disease in patients who receive services from the Struga Institute for nephrology;

To classify these parameters by their degree of risk;

To compare different age groups on the basis of: BMI – how BMI varies in different stages of renal disease;

Nutrition – non caloric food consumption increasingly has become routine in modern societies, whereas ways of consuming calories has consequences on human health, such as cardiovascular diseases, obesity, etc.

Physical activity – the dynamics and trends of modern living drive people to engage in less physical activity. Exercise can help kidney patients return to activities that they did before diagnosis. This brings not only physical benefits, but emotional ones as well.

Social Situation - low standard of living, poverty, unemployment also appears to be risk factors for cardiovascular disease;

Psychological factors - stress is a response or change with emotional, physical, or economic origins that lead to psychosomatic disorders in the body. These changes in the organism can lead to changes in health such as: hypertension, diabetus mellitus, various cancers, etc.

More specifically, our study aims to present research on the correlation between BMI, coagulation factors, blood glucose, lipid parameters and potential risk factors for cardiovascular and nephrotic diseases in different age groups, the changes and impact of these factors on the body.

Materials and methods

In this research, 257 individuals of different ages were studied from the population of Republic of Macedonia, individuals who had been hospitalized in Struga Institute of nephrology. This study was conducted in February 2012. This study was approved by ethics Committee of this institute.

As a way to unify and interpret these measurements we used a BMI and other social factors, such as physical, health and anthropological factors.

All measurements were performed at the health facility. Surveys were also conducted for gathering information about gender, age, weight, height, eating habits, socioeconomic status, and education. The data were analyzed by different age groups:

Individuals between 0-30 years

Individuals between 31-40 years

Individuals between 41-50 years

Individuals between 51-60 years

Over 60 years

The BMI was calculated according to standard methodology, applied to various strata of the population of Macedonia, including different genders, ages, and nationalities. Patients' biochemical parameters examined include: glucose, urea, creatinine, proteins, human albumin, uric acid, cholesterol, triglycerides, potassium, calcium, sodium, total calcium and iron. Venous blood was obtained with a sterile needle under vacuum to about 20micro liter 20% sodium citrate reagent. This blood was centrifuged with a Hitachi centrifuge at 6000 turns per minute for 15 minutes. In this way the plasma was separated from the figured elements of the blood, while the serum was to be used for experiments or stored in a refrigerator (+5 oC). These parameters were measured in the Biochemical Laboratory of the Faculty of Medicine at the University of Tetovo, the Biochemical and Physiological Laboratory of the Biology Study Program, Institute for Nephrology in Struga, and the Tetovo Albimeditika Laboratory. The laboratories use contemporary methods for measuring these parameters such as advanced biochemical and spectrophotometric methods.

Results and discussion

This clinical research studied 257 patients, 143 males and 114 females. Table 1 illustrates the distribution by age group and gender of the patients included in this study.

Table 1. Distribution of patients with nephrotic disease by age groups

Age groups	Males	%	Females	%	Total	%
0-30	8	5.6	3	2.6	11	4.3
31-40 years	45	31.5	21	18.4	66	25.7
41-50 years	46	32.2	59	51.7	105	40.9
51-60 years	34	23.7	20	17.5	54	21
>60 years	10	6.9	11	9.6	21	8.1
Total	143	100%	114	100%	257	100%

According to measurements performed, the average BMI before dialysis of both sexes is 24.49, and after dialysis 22.27. This can be explained by the fact that after dialysis patients lose 2-4 kg in weight and a few centimeters in height over the long term. Charts showing BMI before and after dialysis for both sexes are presented below.

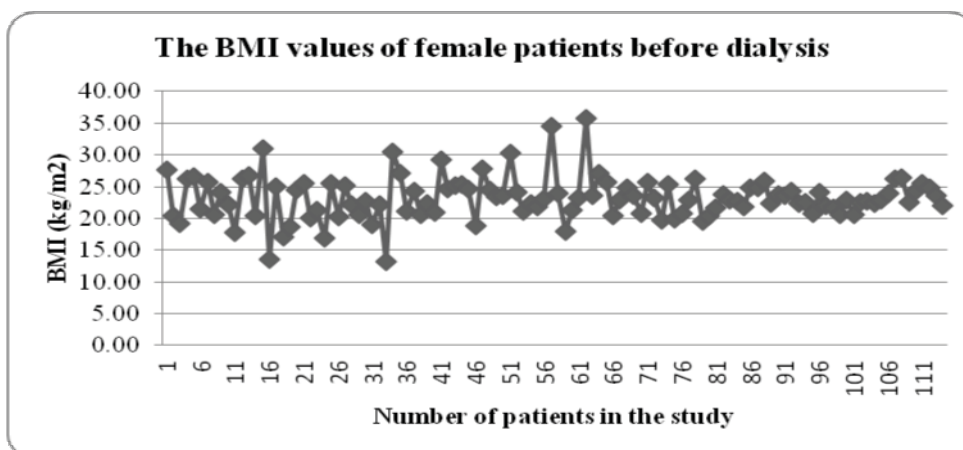


Figure 1. Measurement of body mass index (BMI) prior to dialysis to female gender. The BMI values of female patients before dialysis are presented in Figure 1, above. According to the distribution of values, six patients had a BMI value of greater than 30 kg/m², where only one patient appears to have a BMI over 35 kg/m². Only two patients have a BMI of less than 15 kg/m². Most patients had BMI values within the range of 20-25 kg/m².

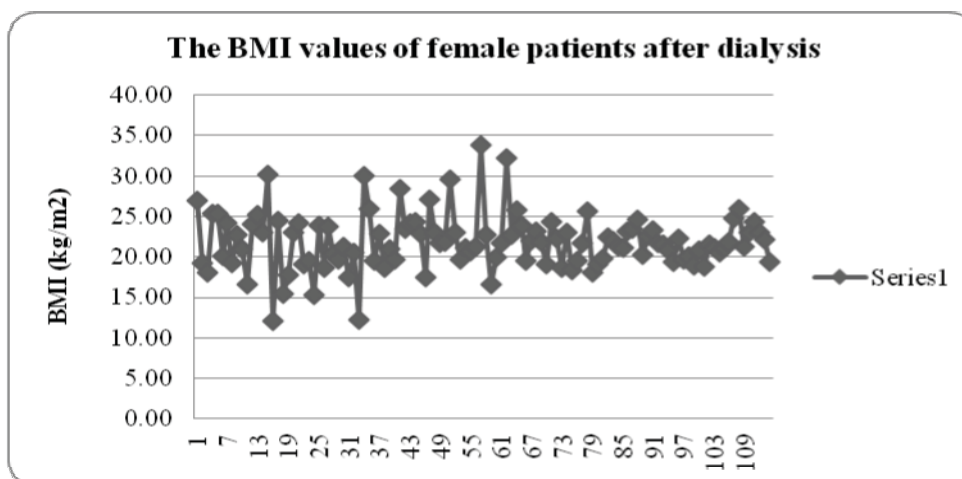


Figure 2. Measurement of body mass index (BMI) after dialysis to female gender

Figure 2 shows that the BMI values of female patients decreased significantly compared to BMI values before dialysis. This chart shows a symbolic drop of values, such that there are no patients with a BMI over 35 kg/m², and BMI values of over 30 kg/m² are found only in two patients, in contrast to the six patients in that range before dialysis. A large number of patients who were in the range of 20-25 kg/m² before dialysis, shifted to the interval with a BMI of 15-20 kg/m², thus marking a significant decrease of BMI for these patients.

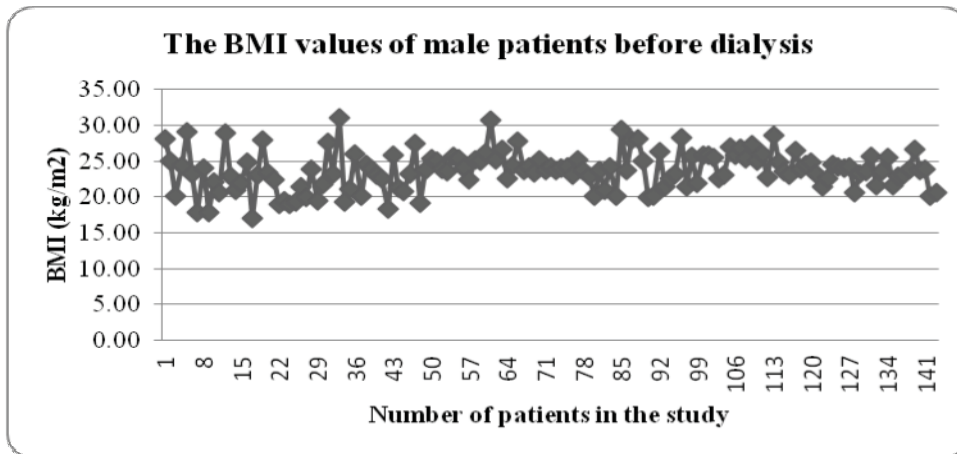


Figure 3. BMI values for males before dialysis

In Figure 3 are shown BMI pre-dialysis values for males. If we compare these values with the pre-dialysis values to female gender, it is clear that the BMI values before dialysis are lower. Among the male patients only two have BMI values higher than 30 kg/m^2 , while six female patients had BMI values higher than this. However, most male patients had BMI values in the range of $20\text{--}25 \text{ kg/m}^2$, meaning that these patients' situation has not changed because the parameters are at the normal limit.

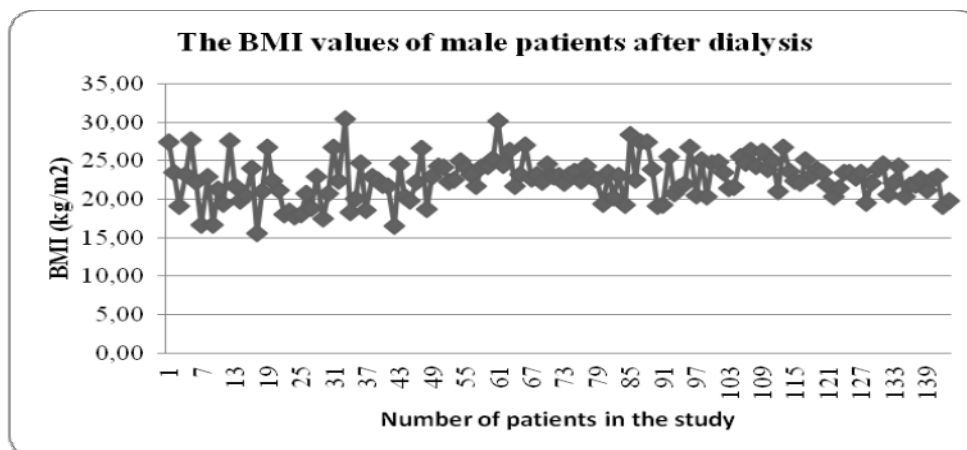


Figure 4. After dialysis values of BMI for males

Figure 4 presents BMI values for males after dialysis. In this figure, the decrease of BMI values in relation to the condition of patients before dialysis is clearly visible. This figure also shows patients with a BMI of 15 kg/m^2 , and BMI values for many patients from the range of $20\text{--}25 \text{ kg/m}^2$ were also reduced to the range of $15\text{--}20 \text{ kg/m}^2$. According to measurements carried out, the average BMI before dialysis of both sexes was 24.49 kg/m^2 and after dialysis is 22.27 kg/m^2 . This is explained by the fact that patients lose 2–4 kg after dialysis as well as a few centimeters of height over two or more years⁷. About 29% of female patients before dialysis had BMI values over 25 kg/m^2 (meaning that they were overweight), obesity and underweight rates are highly symbolic, but this category of patients is present in the study, too.

The normal values of BMI ($18\text{--}25 \text{ kg/m}^2$) are found in 61% of cases. This BMI value of 25 kg/m^2 after dialysis lowers at 11%, again showing that patients lose weight after dialysis. The results also show a reduction of normal BMI cases from 61% before dialysis to 52% after dialysis, and the increase of underweight patients from 21% to 35%. 44% of male patients in the study had a BMI value

above the normal limit of 25 kg/m^2 (overweight) before dialysis, 1.39% with obesity, 3.8% underweight, and 51% with normal weight. After dialysis the percentage of overweight males lowers to 31%, obesity to 0.81%, and the percentage of underweight males increased to 24%, whereas normal BMI levels were found in 44% of the male patients.

Table 2. Biochemical Values Analyzed in Patients before Dialysis

Age groups	Glucose (mmol/L)	Cholesterol (mmol/L)	Urea (mmol/L)	Creatinine (μ mol/L)	Uric acid (μ mol/L)	K ⁺ (mmol/L)	Arterial pressure
0-30 years	4.42	4.31	16.40	590	221	6.67	115/70
31-40 years	6.23	4.90	31.21	612	328	7.87	120/90
41-50 years	6.91	4.70	34.95	890	379	7.90	145/90
51-60 years	7.12	5.12	28.77	772	356	7.43	150/110
> 60 years	7.31	5.02	27.45	745	319	7.11	130/90

The distribution of glucose values before dialysis by age group is variable. According to recent studies, glucose was found not to play any role in the process of glomerular filtration. From Table 2 it is clear that glucose values do not have any drastic increase but they appear with values of 4.42–7.31mmol/L. Lower values of glucose are observed in the youngest age group (0-30 years), at 5 mmol/L, and the oldest age group (>60 years), where the value of glucose is approximately 7.31 mmol/L.

According to the analysis presented in Table 2, higher values of cholesterol are obtained in the fourth age group, which reaches 5.12 mmol/L, whereas lower values are obtained in the first age group which reaches 4.31 mmol/L.

Regarding the measurements of the concentration of the urea in blood, we found lower values of urea in the first age group (0-30 years), 16.40 mmol/L before dialysis, and higher values for the third age group (31-40 years) which reach up to

34.21 mmol / L.

The distribution of creatinine values in patients before dialysis shown in Table 2 shows that the majority of patients were found to have irregular values (too high) of creatinine in pre-dialysis patients. The highest average values occur in the third age group (41-50 years), at 890 mol/L, and lower values of creatinine are found in the first human age group (0-30 years) with a value of 590 micro mol/L.

Uric acid values before dialysis increases from the first age group to the third age group, from 221.98 micro mol/L to 379.29 micro mol/L. The distribution of values in the pre-dialysis potassium from the first to the third age group tends to increase from 6.67 mmol/L up to 7.90 mmol/L in the third human age group; for the fourth and fifth age groups these values suffer a significant decrease at 7.43 mmol/L and 7.11 mmol/L, respectively.

Table 3. Biochemical Values in Patients After Dialysis

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Age groups	Glucose (mmol/L)	Cholesterol (mmol/L)	Urea (mmol/L)	Creatinine (μ mol/L)	Uric Acid (μ mol/L)	K ⁺ (mmol/L)	Arterial Pressure
0-30 years	4.74	4.52	11.21	345	198	4.49	115/70
31-40 years	6.25	5.0	17.38	455	300	4.84	120/90
41-50 years	7.10	4.98	14.90	390	329	6.01	145/90
51-60 years	7.25	5.14	18.73	419	298	4.40	150/110
Over 60 years	7.30	5.01	16.33	323	293	5.05	130/90

As can be seen in Table 3, there are no large differences of glucose values after dialysis from the measurements taken before dialysis. The most obvious difference is observed in the first age group (0-30 years) and in the third age group (41-50 years). In the first age group there is no great increase in the value of glucose from 4.42 mmol/L before dialysis to 4.74 mmol/L after dialysis, whereas in the third age group we have an increase from 6.91 mmol/L to 7.10 mmol/L. For other age

groups, we have almost very similar values for both genders of patients in the study.

Even after dialysis there are different distributions of cholesterol values according to age groups. Compared with the pre-dialysis state, there is a barely noticeable increase of values, but it is seen mostly in the third age group, from 4.70 mmol/L before dialysis to 4.98 mmol/L after dialysis. This increase was characteristic only for patients who have also been diagnosed with hyperlipidemia.

The measurement of urea blood concentration is found with lower urea values for the first age group (0-30 years), at 11.21 mmol/L after dialysis, but with higher values in the second age group (31-40 years), with measurements after dialysis taken at 17.38 mmol/L.

After dialysis patients' values of creatinine are normalized and are found within reference values. Higher reduction of these values are observed in the fifth age group (>60 years), from 745 micromol/L before dialysis to 323 micromol/L after dialysis.

After dialysis slightly lower levels of uric acid are found, but this situation has no specific meaning from the perspective of kidney physiology. Table 3 shows the lowest values in individuals of the first age group (0-30 years), with the value of 198.87 micromol/L and higher values occur in the third age group (41-50 years), with the value of 379.29 micromol/L.

After dialysis, potassium values decreased for all age groups, and these values are reference values for this very significant parameter for nephrotic diseases. A significant drop of values is seen in the second age group (31-40 years) and fourth age group (51-60 years), both reducing to a value of 3.03 micromol/L.

As can be seen from Table 2 and 3 values of arterial pressure and smoking did not change even after patients undergo dialysis.

De Mutsert et al⁹, examined the interrelation of BMI and mortality in hemodialysis patients among the general population for a period of 7 years. Their study showed that obesity (BMI > 30kg/m²) is associated with high mortality for 95% of patients, but in addition to patients with chronic renal disease that should receive special attention, patients who are underweight should also be given attention, because they have a high mortality risk rates.

Conclusion

From the results of this research this paper can be considered among the first works of its kind in the region of the Republic of Macedonia, and in connection with determining the correlation between BMI and risk factors for cardiovascular and nephrotic disease to different human age groups. Analysis of biochemical parameters and BMI gives thorough information about risk factors for cardiovascular and renal disease and measures that should be taken to prevent these diseases.

Our study on BMI shows an increase among both sexes in the number of underweight patients with high values of cholesterol and triglycerides. This is associated with the scientific evidence that weight loss in these cases may be related to deaths caused by cardiovascular diseases⁸.

After the discovery and identification of renal disease, the impact of BMI can be distinguished from pathological processes, such as irregular eating, various inflammations, and changes in the metabolism of vitamin D, etc. Many studies show that individuals with a BMI range lower than the range of obesity, including the BMI range for overweight, are associated with the last stage of renal disease.

Compared with normal values of BMI, overweight and obese BMI values are independently associated with stages of renal disease including chronic renal disease, where disease prevention or treatment can be effective¹⁰⁻¹¹. However, dilemmas dealing with the interrelation of BMI and renal disease still remain unexplained and leave us further opportunities for continuing research in this direction. It is not entirely clear whether there is a consistent association between BMI and chronic renal diseases, we therefore recommend investing future research in these deadly diseases. The results of our research could provide a valuable contribution to the field of nephrology in particular and in the medical field in general, so a scientific investment in this direction may produce useful innovations for treating cardiovascular and nephrotic diseases.

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