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RESEARCH ARTICLE

Opportunities for the Prevention of Hypertension by Nutrition Correction

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Abstract

Introduction: There is much evidence of a relationship between salt intake and blood pressure levels. Limiting sodium chloride consumption significantly lowers blood pressure.The purpose of this study was to study the effectiveness of lowering blood pressure while limiting salt intake in men and women with high and normal blood pressure. Materials and methods:. An annual study was conducted, a prerequisite of which was the selection of 2 groups: survey and comparison. They were comparable in terms of gender, age, professional composition and number of participants. To carry out a dietary examination required limiting the salt in the cooking to 0,5 g per serving. Results and discussion: After one year of dietary intervention, a significant decrease in systolic (SBP) and diastolic blood pressure (DBP) was found in men and women in the intervention group ($p < 0,05$) compared to the control group, which showed a natural decrease in blood pressure, a significant decrease in blood pressure was observed during the study period ($p < 0,05$). In addition, there was a significant decrease in body weight in the intervention group compared with the control group. Conclusions: Reduced salt intake significantly reduced SBP and DBP in men and women with high blood pressure over a longer follow-up compared with the control group.

Keywords: *Hypertension, Prevention, Salt, Population research.*

Introduction

About 30 % of the adult population of Ukraine suffer from arterial hypertension (AH). It is well established that hypertension increases the risk of coronary heart disease, stroke, and cardiovascular complications [1]. At lowering blood pressure (BP), this risk is reduced [2]. An effective non-pharmacological strategy for reducing blood pressure is to apply a dietary approach to the treatment of hypertension (DASH) [3]. The DASH diet, approved by several national recommendation committees, is used in patients with blood pressure above normal [4-6].

Non-drug approaches are an important aspect in the prevention and treatment of hypertension [7-10]. The recommendations focus on non-drug therapy for hypertension, namely, limiting sodium chloride consumption, as this measure has long been considered effective. The positive relationship between salt intake and blood pressure was first described about 100 years ago. In 1948, non-drug treatment of patients with arterial hypertension with a salt-free rice-fruit diet was proposed [11]. And now there is ample evidence of a cause and effect relationship between salt intake and blood pressure, which has emerged in many epidemiological, experimental and clinical studies [12-14].

About 5,000 years ago, salt began to be used as a preservative for food storage, the peak of salt consumption fell by 1870. Theoretically, with the invention of freezers, refrigerators of salt consumption would have declined, but according to a large international study [15], currently salt consumption in many countries ranges from 9 to 12 g/day. Whereas many years ago people ate solely natural foods without the addition of salt, their diets contained approximately 0,5 g of salt, or 0,2 g of sodium chloride per day [16].

A recent review that included 167 studies [17] confirms that salt restriction lowers blood pressure. In addition to reducing blood pressure, reducing sodium chloride intake can prevent the development of hypertension and improve blood pressure control with antihypertensive therapy.

It has been estimated that reducing salt intake to 6 g (2,400 mg sodium chloride) per day could reduce stroke risk by 24 % and coronary heart disease (CHD) by 18 % per year and prevent 2,5 million deaths from stroke and CHD in worldwide. The purpose of this study was to investigate the possibility of preventing hypertension by directed correction of nutrition over an annual period in an organized population of men and women with high BP and risk factors (FR) for the development of hypertension.

Materials and methods

An annual study was conducted, a prerequisite of which was the selection of 2 groups: survey and comparison. They were compared by gender, age, professional composition and number of participants. To carry out a dietary examination required limiting the salt in the cooking to 0,5 g per serving. One of the possible options for the implementation of primary prevention of hypertension based on organized populations among the working population was adopted.

The study included 1568 patients diagnosed with hypertension. The criteria for the inclusion of patients in the study were: the presence of hypertension I-II degrees and age from 30 to 65 years. Further, patients were divided into 2 groups. The mean age of the patients was 59,7 ± 0,8 years, for women - 60,6 ± 1,0 years, for men - 57,4 ± 1,5 years. The study involved 653 men and 915 women. The duration of the disease ranged from 1 year to 35 years, with an average of 12 ± 0,98 years.

The research program consisted of several stages: 1st screening initial screening (visit), repeat prospective visit and final examination. A total of 1568 people were interviewed for nutrition, 1176 of whom wished to change their diet. Dynamic observation of groups 1 every 6 months, then after 1 year final screening.

The primary survey was conducted in populations of an identical program, which included filling in a short questionnaire with information on family history of hypertension and data on the intake of antihypertensive agents, two-time measurement of blood pressure on the right arm with mercury sphigomomanometry. Individuals who answered «yes» to the questionnaire about the desire to change nutrition were referred to a dietitian-therapist for individual nutrition advice explaining the purpose of the intended diet. As a result of this visit, two groups were formed: a survey group and a comparison group by the following criteria:

- Persons who at the initial examination BP = 130-139/85-89 mm Hg,
- Persons from BP < 130/85 mm Hg, but with a heart rate > 85 beats/min (sitting alone).
- Persons from BP < 130/85 mm Hg, heart rate < 85 beats/min, but with a positive family history of arterial hypertension.

Along with the indications for inclusion in the group of primary prevention of hypertension, there were some contraindications. These included the presence of coronary heart disease and other serious cardiovascular diseases, diabetes mellitus, severe obesity (BMI > 40 kg/m^2) and pronounced changes in lipid metabolism, pregnancy, alcohol abuse, non-contact behavior, inability to tolerate various causes, prescribed diet and undergo periodic examinations.

In the group of non-drug treatment, a dietary examination program and prospective monitoring of its participants were conducted. 1176 persons received individual consultations. Prospective visits were necessary to support the motivation to adhere to a salt-restricted diet. In the comparison group (392 people), information about individuals with similar characteristics was transmitted to the clinic by family physicians, in whom they were observed during the regular annual medical examination.

Research Methods

- Survey on a specially designed questionnaire, which was handed out to participants for self-completion on the eve of the initial visit. The questionnaire included information on the disease, the presence of hypertension and heredity in relation to the disease, a questionnaire to detect angina, information on alcohol consumption and smoking.
- Measurement of blood pressure was carried out in a sitting position, 10-15 min after rest, with a mercury sphygmomanometer.

The arithmetic mean of 2 measurements was estimated.

- The electrocardiogram was recorded in the supine position with 12 standard leads.
- The pulse rate was calculated sitting at rest for 30 s.
- Anthropometric examination was performed 1 time, in the standing position without shoes, to the nearest 1 cm. Mass was determined 1 time to the nearest 0,1 kg. MT estimation was performed on BMI in kg/m^2.

Actual nutrition has been studied using the standard method of daily dietary interrogation using food dumplings (N.G. Khaltayev and B. Dennis, 1976).

A questionnaire was conducted about the habit of eating food during the meal (to account for all salt consumed during the day). Statistical analysis was performed on the basis of the EpiInfo software package. Standard methods of variational statistics were applied: calculation of mean, standard errors. An analysis of indicators was used to evaluate the results.

The significance of differences between the mean values was estimated using the Student's coefficient. Differences in which $p < 0,05$ were considered statistically significant.

Results and Discussion

The study protocol indicated the number of patients examined at baseline (a total of 915 women and 653 men aged 30 to 65 were examined in 2 populations). 1176 individuals in the survey group and 25 % of the representative sample in the comparison group were interviewed for a daily dietary diet and answered the questionnaire about the habit of eating a meal.

The survey and questionnaires it turned out that salt consumption in the two populations was 12 g, which corresponds to 480 mg of sodium chloride. On the last visit a year group in the survey came from 1058 persons (response 90 %), in comparison group - 298 persons (opinion 76 %). The characteristics of the survey and comparison groups according to the initial visit for men and women aged 30 to 65 are presented in Figure 1.

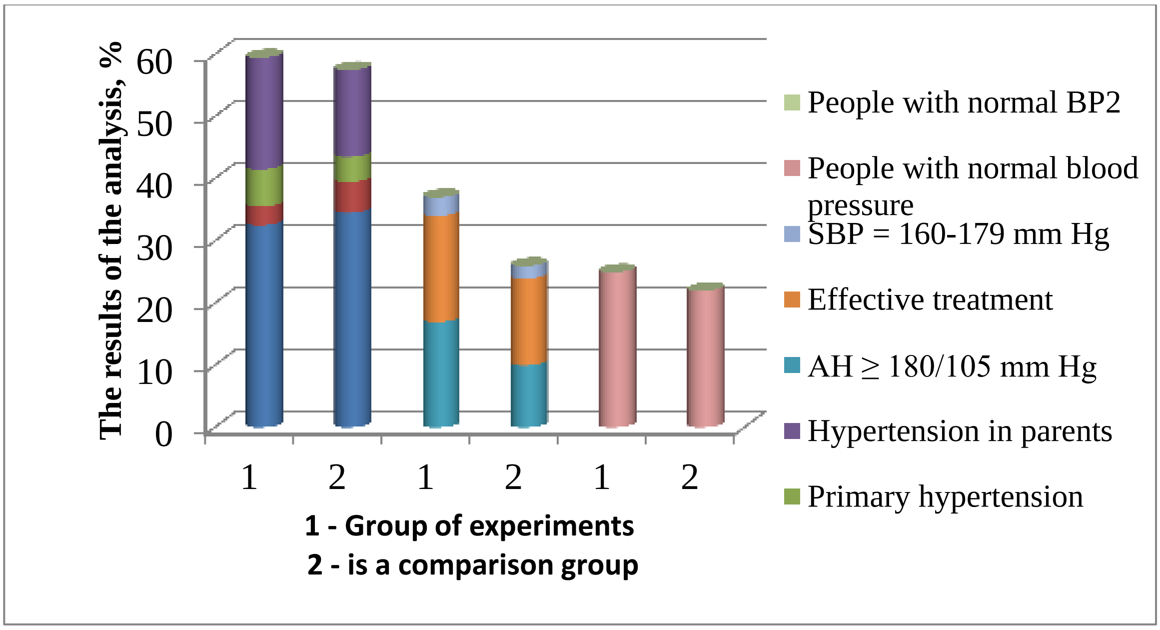

Fig. 1: Characteristics of survey groups and comparisons according to the original visit

The results of the analysis showed that 32,5 % in the comparison group and 34,5 % in the study group were individuals with high blood pressure. 3,0 % and 5,0 %, respectively, is the proportion of people with tachycardia at rest (heart rate - HR > 85 beats/min). 6,0 % and 7,0 % were individuals who had a history of high blood pressure (BP > 140/90 mm Hg). 18,0 % and 14,0 % are persons with normal blood pressure but a positive family history of hypertension. 25 % in the survey group and 22,0 % in the comparison group were individuals with normal BP. 22,0 % in the study group and 18,0 % in the comparison group were individuals with hypertension. Effective treatment of hypertension was observed in 17,0 % in the study group and 14,0 % in the comparison group. 3,0 % in the study group and 2,0 % in the comparison group were individuals with blood pressure 160-179 / 95-104 mm Hg. Persons with BP > 180/105 mm Hg in the survey sample amounted to 17,0 %, in the control group - 10,0 %.

In the surveyed organized populations, such factors as hypertension, such as smoking, alcohol consumption and increased body mass index (BMI), were predominant in men, while women had heavier heredity and increased body mass index. A stepwise regression analysis revealed relevant relationships between blood pressure and salt intake in men and women ($p < 0,001$).

An analysis of the impact of significant indicators on the level of blood pressure is presented in Table 1 and Table 2. A correlation ($p = 0,001$) between age and SBP was detected in both men and women (see Table 1). Thus, with increasing age by 1 year in women, SBP increases by 0,5, in men - by 0,4 mm Hg. 25 % of SBP variability is explained by age in women and 11 % in men. BMI is as follows related to SBP- dependence is also relevant in women ($p = 0,0001$) and men ($p = 0,0045$): with an increase in BMI by 1 kg/m^2, the SBP increases by 1,4 mm Hg in women and 0,9 mm Hg in men.

20 % of the variability of SBP can be explained by the influence of body weight in women and 29 % in men. The frequency of alcohol consumption in women does not affect the level of SBP ($p = 0,0991$) and in men 11 % of the variability of SBP is explained by the frequency of alcohol consumption. Burdensome heredity for hypertension does not affect the level of SBP in either women or men (women $p = 0,8$, men $p = 0,08$).

Table 1: Indicators significantly associated with the level of systolic blood pressure

Indicator	**Women** (N=915)			**Men** (N=653)		
	β	**R^2**	***p***	**β**	**R^2**	***p***
	60,6			57,4		
Age, years	0,5	0,2	0,0001	0,4	0,09	0,0001
BMI, kg/m^2	1,4	0,2	0,0001	0,8	0,3	0,0045
Alcohol (frequency of use)	2,5	0,02	0,0991	6,6	0,12	0,0123
Heredity	3,0	0,3	0,8101	2,3	0,02	0,0784
Pulse rate	0,08	0,03	0,0012	0,06	0,17	0,0041

Note. here and in the table 2: R2 is the regression coefficient, β - is the regression equation coefficient, p - is the probability that β = 0.

Table 2: Indicators significantly associated with the level of diastolic blood pressure

Indicator	**Women (N=915)**			**Men (N=653)**		
	β	**R^2**	**P**	**β**	**R^2**	***P***
	60,6			57,4		
Age, years	0,3	0,2	0,0001	0,2	0,14	0,0013
BMI, kg/m^2	0,8	0,18	0,0001	0,9	0,11	0,0001
Alcohol (frequency of use)	2,6	0,05	0,0991	3,7	0,14	0,0538
Heredity	0,98	0,02	0,8101	1,9	1,2	0,0971
Pulse rate	0,06	0,07	0,0012	0,07	0,04	0,0422

Indicators related to the level of DBP are presented in table 2. The level of DBP in both women and men is influenced by age (in women $p = 0,0001$, in men $p = 0,001$). With increasing age by 1 year, the DBP increases by 0,2 mm Hg both of them. 21 % of the variability of DBP can be explained by age in women and 14 % in men. The effect of body weight, expressed in the tables as BMI $p = 0,0001$ in both women and men. With an increase in BMI by 1 kg/m2, DBP increases by 0,8 mm Hg in women and 0,9 mm Hg in men. 19 % of the variability of DBP can be explained by a change in BM in women and 12 % in men. Frequency of alcohol consumption did not affect DBP in either men (p = 0,053) or women (p = 0,013). Heredity is associated with the level of DBP only in women (p = 0,013), as in men this relationship is insignificant (p = 0,097). 22 % of the variability of DBP in women can be attributed to burdened heredity. These correlations suggest a different distribution of risk factors for hypertension between men and women. The same factors differently affect blood pressure levels in the surveyed population and are gender dependent.The results of the annual dietary survey on salt restriction are shown in Table 3.

Table 3: Results of the annual dietary survey

Indicator	Survey group (n=1176)		Comparison group (n=392)	
	Women (n=708)	**Men** (n=466)	**Women** (n=218)	**Men** (n=174)
SBP[1]	135,79±1,48	136,12±2,26	136,12±2,26	136,27±1,20
SBP[2]	131,52±1,16	133,20±2,67	140,09±1,24	139,83±2,07
DBP[1]	86,82±0,59	86,66±0,63	86,94±1,12	85,96±0,61
DBP[2]	83,73±2,23	84,03±0,67	89,23±1,95	89,35±2,22
BM[1]	77,45±1,24	72,19±1,1	78,05±1,01	69,17±1,90
BM[2]	74,02±1,17	69,56±0,68	83,07±3,08	76,33±2,89

[1] – output data
[2] – final data

The SBP, DBP and BM values measured at the initial visit did not differ significantly for either men or women in the study group and comparison group (p > 0,05), the groups could be compared with each other. At the last visit, the SBP, DBP and BM indicators differed significantly from the measurements at the initial visit, prior to the start of the survey (p < 0,05).

Thus, there was a significant decrease in SBP in women in the study group by 4,27 mm Hg, in men - by 2,92 mm Hg. DBP in the study group in women significantly decreased by 3,09 mm Hg, in men - by 2,91 mm Hg. BM significantly decreased in women by 3,43 kg, in men - by 3,63 kg. In the comparison group, the natural dynamics of BP and BM occurred. Yes, SBP significantly increased in women by 3,97 mm Hg, in men - by 3,56 mm Hg. DBP significantly increased in women in the comparison group by 2,29 mm Hg, in men - by 3,39 mm Hg. BM probably increased by 5,02 kg in women and 7,16 kg in men.

Conclusion

The results of the analysis of the prevalence of risk factors for hypertension in the organized population showed that about 60 % of people require non-medication control of hypertension, of which 32,5 % in the comparison group and 34,5 % in the study group are persons with high blood pressure, 3,0 % and 5,0 % - the proportion of people with tachycardia at rest (heart rate > 85 beats/min). 6,0 % and 7,0 % were individuals who had a history of high blood pressure (BP > 140/90 mm Hg).

18,0 % and 14,0 % are persons with normal blood pressure but a positive family history of hypertension. Significant gender differences were found in the relationship between hypertension factors with blood pressure, which correlated positively with age and BMI in men and women, with alcohol consumption - only in men and with heredity - only in women.

As a result of an annual dietary survey to limit sodium intake to 2,4 g (6 g of salt), the potential for a non-drug approach to the prevention of hypertension in the population was identified: a significant reduction in blood pressure and BM in compared with the control group.

Discussion

In 2003, the seventh report of the Joint

National Committee for the Prevention, Diagnosis, Assessment and Treatment of High Blood Pressure outlined the latest guide to the prevention and treatment of hypertension [4], in which one of the main issues was the creation of a new category of hypertension, which included pre-hypertension persons with SBP from 120 to 139 mm Hg or DBP - from 80 to 89 mm Hg. Patients with high blood pressure have been shown to be at increased risk for the development and progression of hypertension (2 times higher than those with lower values in the short term and at increased risk of cardiovascular disease [18,19]. In 2007, ESH/ESC the Committee has decided against the use of the term «pre-hypertension» for a number of reasons [9].

In this study, the main survey and comparison groups were formed from individuals with high blood pressure or pre-hypertension. In the study of salt consumption in the populations we surveyed, it was found that the average value is 12 g (4,8 g of sodium chloride). In this, our data is consistent with epidemiological data worldwide and optimal daily salt intake is 6-7 g, approximately 1/2 of the existing average salt intake [20], whereas, for example, in the past centuries, people consumed approximately 1/20 part of the salt now consumed. It is suggested that people today consume approximately 20 times more sodium chloride (salt) than the minimum required by the human body [21].

In order to prevent the development of hypertension by correcting nutrition mainly by limiting salt (sodium chloride) intake by 50 %, that is, in the study group, individuals who agreed to change their diet changed to salt regimen after individual nutrition consultation (2,4 g of sodium).

Despite regular consultations to support the adherence to dietary recommendations, reducing sodium consumption also requires efforts from patients. J. Fitzsimons [22] believes that the efforts of patients to limit salt are associated with the development of potent salt appetite, since for a long time people have been living in sodium deficiency, and this inherent desire for salty foods makes it difficult to achieve a sharp reduction in salt consumption.

The results of this study demonstrated the effectiveness of sodium chloride restriction in individuals with high blood pressure. Salt restriction reduces blood pressure by reducing extracellular fluid volume, such pathophysiological action is provided by diuretic therapy [23]. The universal recommendation is to consume 10 g of salt per day, and the lower the better.

The World Health Organization recommends 5 g or less, especially in populations known for excessive salt intake and high AH prevalence [7]. The analysis of 23 randomized controlled trials showed that a reduction in salt to 100 mmol (2,3 g) per day was associated with a decrease in SBP by 5,7 mm Hg, DBP at 2,7 mm Hg at hypertension and SBP on 2,2 mm Hg, DBP at 1,3 mm Hg in individuals without hypertension [24].

This analysis raises the question of the advisability of a salt restriction recommendation for everyone. The authors noted the adverse effects of salt restriction on cardiovascular disease other than BP: there was a significant increase in renin and aldosterone activity, as well as an increase in catecholamines and lipids. This study also found a large relationship between salt intake and blood pressure by a stepwise regression analysis.

The review shows a linear relationship between salt intake and blood pressure and, as the authors point out, ignores the possibility of adverse effects of reducing salt intake, namely: a significant increase in plasma cholesterol by 2,5 % and triglycerides - 7 %. Renin and aldosterone, as they play an important role in the regulation of blood pressure and are associated with an increase in cardiovascular mortality, as noted in later long-term studies. In the DASH studies [21] the high efficiency of BP reduction with limitation of salt consumption was noted.

This study also analyzed the change in body weight in the survey group and the comparison group. Reduction of salt intake by persons on antihypertensive therapy improves blood pressure control and reduces the need for drug therapy.

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