JPSIM Journal of Pakistan Society of Internal Medicine

Original Article

An Association of Salt Intake with Life Style Related Diseases and Customarily Taken Diet in Women of District Bannu: A Cross Sectional Study

Zakkia Khan,[1] Radhia Khan,[1] Samiullah Khan,[1] Wasim Ahmad[2]

[1]Bannu Medical College Bannu-KP, [2]Allied Health Sciences, SHS Peshawar-KP

Abstract

Objective: To investigate the association of salt intake with lifestyle associated diseases in women of district Bannu as well as foods that are taken habitually in routine life.

Methods: This cross sectional regional study was conducted from January 2020 to June 2022 in Khyber Pukhtunkhawah using a baseline survey data of 1500 patients (738 non-conceived and 762 conceived) having an age between 30-40 years and who undergone an annual check-up at a tertiary care hospital of district Bannu-KP. We designed a questionnaire to assess the patient's wellbeing and life style. Participant's BMI, height, weight, circumference were measured respectively by standard methods. Blood pressure and routine laboratory examinations were carried out at hospital's lab. Salt intake was estimated through urinary creatinine and urinary Na^{+}.

Results: All the study participants were divided into three groups based on their daily salt consumption. The groups were termed as Low, Medium & High salt consumers. We assessed the prevalence of life style related diseases including DM and HTN in an increasing order in groups as High, Medium & Low salt consumption ($p \leq 0.001$). In non-conceived group, the maximum daily salt ingestion was recorded as 12.5 to 13.5 g/day and displayed a normal distribution. In conceived group, the maximum salt ingestion was recorded as 11.5 to 12.5g/day. The quantity also showed a normal distribution. Out of 738 male population, 37.94% (n=280) fall in the group with lower salt consumption (≤ 10.4g/day), 41.19% (n=304) in medium salt consumption and remaining 20.86% (n=154) in high salt consumption group (≥ 13.8 g/day). The distribution of female were as: 40.41% (n=308) in low salt consumption group (≤9.0g/day), 43.83% (n=334) in medium and remaining 15.74% (n=120) in high salt consumption groups (≤12.2 g/day),

Conclusion: The study examined lifestyle associated diseases linked with excessive salt intake and dietary habits that contributed to lower salt consumption. The prevalence of HTN, higher DM and higher BMI was associated with higher salt consumption in both non-conceived and conceived females. Knowledge of low salt consumption did not play a significant role in salt reduction. We suggest a dietary move to several vegetables intake that could have salt lowering effects.

Keywords: body mass index, diabetes mellitus, dietary habits, salt consumption, life style related diseases

How to cite this:

Khan Z, Khan R, Khan S, Ahmad W. An Association of Salt Intake with Life Style Related Diseases and Customarily Taken Diet in Women of District Bannu: A Cross Sectional Study. J Pak Soc Intern Med. 2023;4(1): 35-41

Corresponding Author: Wasim Ahmad **Email:** vazim4847@gmail.com

Introduction

Numerous physiological actions, including absorption of nutrients in the GI tract, body osmolality and muscles & nerves excitation are regulated by the presence of adequate amount of sodium salt in the body.[1] However, this is obvious that excessive intake of sodium salt can exacerbate various abnormalities like blood pressure and thus, risk of cerebrovascular and renal abnormalities increases four folds.[2] As a result, many other conditions including asthma, osteoporosis and gastric cancer are implicated.[3-5] The optimal recommendations for sodium intake as a nutrient are 5g per day. This recommendation is in accordance with a technical report presented by WHO. In Pakistan, the number of patients with DM and metabolic syndrome are increasing day by day. Increased salt intake is considered as the risk factor for HTN (hypertension) unanimously but the association between higher salt consumption and various diseases

like DM, obesity and dyslipidemia are still contentious.[6-9] It is assumed that high salt intake for a prolonged period can cause insulin resistance and other abnormalities. According to a study, higher salt consumption triggers the "aldose reductase–fructokinase pathway" in the liver and hypothalamus, causing the leptin resistance and manufacture of endogenous fructose.[10] In order to avoid high salt consumption, dietary habits should be clarify for the people. Pakistan is a progressive country with people with lower income and thus, keeping in view the economic conditions of the people, plan for healthy diets should be publicized by the dietitian,

This was the ever first study in KP region that was aimed to assess an association of excessive salt consumption with various metabolic disorders.

Methods

This cross sectional regional study was conducted from January 2020 to June 2022 in Khyber Pukhtunkhawah using a baseline survey data of 1500 female patients (738 non-conceived and 762 conceived female) having an age between 30-40 years and who undergone an annual check-up at a tertiary care hospital of Bannu-KP. We designed a questionnaire to assess the patient's wellbeing and life style.

Anthropometric data and Blood screening

Participant's height measurement was taken in 0.1-cm whereas; weight measurement was taken in 0.1-kg respectively using standard methods. BMI (Body Mass Index) was measure as weighr in kg/height in meter square (m^2). Waist circumference was taken at the umbilical level to the nearest 0.1cm using a measuring tape. The measurement was done in standing position after normal breath. Blood pressure measurement was done from right arm in a seated position at rest for at least 5 minutes. The patient was labelled as hypertensive with a systolic pressure ≥ 140mmHg or a diastolic pressure ≥ 90mmHg. Patients were termed as hyperlipidemic with triglycerides levels ≥150mg/dl, LDL cholesterol levels as ≥ 140mg/dl and HDL cholesterol levels as <40mg/dl. Diabetics were labelled as having HbA1c level ≥6.5 or FBS ≥126mg/dl. Diagnosis of hyperlipidemia, hypertension and DM was done based on the blood reports or patient's medical history. The blood screening tests were done using hospital's laboratory. In order to assess whether high salt intake in associated with an increased prevalence of DM, propensity scoring was used.

Daily salt intake guesstimate and grouping

Using spot urine at the time of the survey, the study participant's urinary sodium and urinary creatinine were obtained for estimation of daily salt intake[14]. The estimated daily salt intake by the study participants was tabularized as histograms separately for male and female grouping.

Questionnaire used in survey

For this study, we used a self-administered questionnaire that was aimed for inquiring about daily life style pattern, participant's eating habits, smoking and drinking habits, exercise pattern, stress in routine working, family and medical history and currently used medications. All the data obtained through questionnaire was used for analysis. As a healthy life style marker, we used data on moderate sleeping habits, non-smokers and non-drinker, daily moderate exercise and use of vegetables.[15,16] The collected data anonymized in order to secure the individual's individuality.

Statistical analysis

The data was analyzed using GraphPad prism 5. Continuous variables were expressed as mean SD. Propensity scoring match for gender, age, height, weight and medication was done in order to compare the prevalence of diabetes and salt intake. A p value <0.05 was considered significant statistically.

Results

Groups based on estimated salt intake

All the study participants were divided into three groups based on their daily salt consumption. The groups were termed as Low, Medium & High salt consumers. We assessed the prevalence of life style related diseases including DM and HTN in an increasing order in groups as High, Medium & Low salt consumption (p≤0.001). Out of 738 non-conceived population, 37.94% (n=280) fall in the group with lower salt consumption (≤ 10.4g/day), 41.19% (n=304) in medium salt consumption and remaining 20.86% (n=154) in high salt consumption group (≥ 13.8 g/day). The distribution of conceived female were as: 40.41% (n=308) in low salt consumption group (≤9.0g/day), 43.83% (n=334) in medium and remaining 15.74% (n=120) in high salt consumption groups (≤ 12.2 g/day). The results are shown in fig 1 and 2. In non-conceived group, the maximum daily salt ingestion was recorded as 12.5 to 13.5 g/day and displayed a normal distribution. In conceived females, the maximum salt ingestion was recorded as 11.5 to 12.5g/day. The quantity also showed a normal distribution.

Life style associated diseases and salt intake

The findings of our study about daily salt intake and prevalence of various diseases including DM, hypertension, dyslipidemia and metabolic syndrome are displayed in table 1 below.

It is evident from the above table that in both groups; the weight and BMI increased with an increased salt intake groups with a p value for trend as 0.002. Similarly, the prevalence of hypertension was observed in an increasing trend with an increase in salt intake (p value for trend=0.001). In conceived females, triglycerides levels were found to be increased with an increase in salt consumption group with p value for trend as 0.001. Furthermore, FBS and Hba1c levels were also increased with an increase in salt consumption. The p value was calculated as 0.001. The prevalence of metabolic syndrome was assessed as increased with an increase in salt intake with p value 0.001 in non-conceived group. The value was not significant in conceived females.

Table 1: *Association between Daily Salt Intake and Various Diseases*

Characteristics	Non-conceived group (n=738)				Conceived group (n=762)			
	Low	Medium	High	*P* value	Low	Medium	High	*P* value
Number (%)	280 (37.94)	304 (41.19)	154 (20.86)		308 (40.41)	334 (43.83)	120 (15.74)	
Age (years)	60.4±8.2	61.8±7.4	63.0±8.0	0.02	58.0±7.2	59.4±8.0	62.6±6.0	0.001
Height (cm)	158.4±8.2	164.8±8.0	168.4±4.8	0.01	152.2±6.2	154.6±6.8	154.8±4.0	0.10
Weight (kg)	64.8±6.0	68.0.4±4.2	70.7±4.0	0.002	54.0±6.0	58.2±6.0	60.8±9.2	0.002
BMI (kg/m^2)	23.0±2.2	24.8±3.1	24.0±2.9	0.002	22.1±1.2	23.8±2.8	24.2±3.1	0.002
BMI ⩾30 (%)	10 (1.4)	6 (0.81)	8 (1.08)	0.21	11 (1.44)	14 (1.83)	16 (2.09)	0.14
Hypertension								
Systolic (mm/Hg)	128.0±5.1	134.8±6.2	132.0±6.0	0.001	120.0±4.0	128.0±5.1	128.6±6.8	0.001
Diastolic (mm/Hg)	80.0±6.2	85.8±6.1	85.3±8.0	0.001	72.1±4.2	73.0±8.8	72.0±7.2	0.001
HTN treated (%)	118 (15.98)	134 (18.15)	122 (16.53)	0.010	112 (15.17)	138 (18.69)	101 (13.68)	0.032
HTN diagnosed at baseline survey (%)	78 (10.56)	106 (14.36)	92 (12.46)	0.004	40 (5.29)	68 (8.92)	64 (6.65)	0.003
HTN treated or diagnosed at baseline survey (%)	116 (15.71)	178 (24.11)	154 (20.86)	0.001	104 (13.64)	144 (18.89)	146 (19.16)	0.002
Hyperlipidemia								
Triglycerides (mg/dl)	127.0±6.2	132.8±8.2	144.2±7.4	0.7	100.8±4.9	104.4±6.0	112.0±6.4	0.001
LDL Cholesterol (mg/dl)	120.2±4.0	124.0±3.5	118.2±4.4	0.80	118.0±8.0	122.0±4.4	116.0±4.8	0.49
HDL Cholesterol (mg/dl)	55.5±10.2	55.8±8.8	59.0±8.6	0.78	70.0±12.0	63.0±8.0	62.2±11.0	0.001
Hyperlipidemia treated (%)	51 ()	62 ()	56 ()	0.12	70 ()	122 ()	78 ()	0.32
Hyperlipidemia diagnosed at baseline survey (%)	145 ()	174 ()	131 ()	0.88	133 ()	198 ()	126 ()	0.22
Hyperlipidemia treated or diagnosed at baseline survey(%)	180 ()	189 ()	162 ()	0.76	180 ()	276 ()	174 ()	0.02
Diabetes								
FBS (mg/dl)	90±18.0	92±20.2	100±16.4	0.028	88±12.0	90±14.6	96±14.0	0.002
HbA1c (%)	5.7±0.4	5.8±0.2	5.9±0.6	0.001	5.4±0.5	5.5±0.5	5.6±0.6	0.001
DM treated (%)	23 (3.11)	32 (4.33)	41 (5.55)	0.007	11 (1.44)	21 (2.75)	37 (4.85)	0.001
DM diagnosed at baseline survey(%)	27 (3.65)	39 (5.28)	44 (5.96)	0.061	16 (2.09)	22 (2.88)	29 (3.80)	0.004
DM treated or diagnosed at baseline survey(%)	33 (4.47)	49 (6.39)	58 (7.85)	0.001	21 (2.75)	29 (3.80)	41 (5.38)	0.001
Metabolic syndrome (%)	34 (4.60)	47 (6.36)	64 (8.67)	0.001	13 (1.70)	16 (2.09)	19 (2.49)	0.064

Salt intake and other baseline characteristics

An association of salt intake and other baseline characteristics are displayed in table 2 below. It is evident from the results that adequate sleep duration increased with an increase in salt consumption in non-conceived group. There was no significant association between salt intake and exercise habits, stress and eating habits.

Association of salt intake and habitually consumed food

An association of daily salt intake and habitually consumed food is given in the table 3, which shows no significant association between daily salt intake and habitually consumed food. However, the use of rice, fruits and fried foods were increased with an increase in daily salt.

Table 3: *Association between Daily Salt Intake and Habitually Consumed Food*

Food Items	Non-conceived group			*p* value for trend	Conceived group			*p* value for trend
	Low	Medium	High		Low	Medium	High	
Chicken	16.2%	19.4%	11.3%	0.311	24.8%	22.0%	18.2%	0.288
Eggs	32.6%	38.8%	36.3%	0.510	48.0%	44.4%	41.0%	0.030
Milk	34.0%	36.2%	35.0%	0.880	42.0%	45.2%	40.2%	0.866
Butter	4.8%	3.6%	3.0%	0.202	1.6%	1.4%	1.0%	0.622
Beef	30.6%	28.0%	28.1%	0.400	44.0%	46.4%	46.0%	0.544
Mutton	31.3%	34.4%	34.6%	0.540	38.4%	34.8%	40.1%	0.444
Fish	52.0%	54.2%	56.3%	0.310	52.2%	58.0%	58.8%	0.040
Rice	80.4%	78.2%	84.6%	0.170	80.8%	82.6%	82.0%	0.030
Salad	40.6%	38.0%	38.0%	0.622	46.0%	48.8%	47.7%	0.881
Vegetables	41.0%	40.4%	38.0%	0.610	44.2%	45.3%	46.6%	0.801
Saag/Lassi	40.9%	34.4%	36.6%	0.601	46.6%	46.2%	44.0%	0.711
Fruits	18.9%	21.4%	22.8%	0.166	40.2%	42.4%	42.0%	0.700
Fried food	30.8%	33.3%	34.4%	0.622	42.2%	44.3%	46.4%	0.732

Table 2: *Associations of Baseline Characteristics and Salt Intake Group*

Non-conceived Group	Low		Medium		High		
	Yes	No	Yes	No	Yes	No	*P* value for trend
Exercise ⩾30min/day	34%	66%	38%	62%	34%	66%	0.88
Sleep 5-7hr	64%	36%	70%	30%	72%	28%	0.02
Stress	70%	30%	78%	22%	76%	24%	0.45
Eating b/w meals	80%	20%	76%	24%	75%	25%	0.62
Bachelors in education	28%	72%	30%	70%	30%	70%	0.71
Salt consumption knowledge	60%	40%	58%	42%	62%	38%	0.24
Taking medication	55%	45%	60%	40%	56%	44%	0.05
Dietary fats knowledge	40%	60%	44%	56%	44%	56%	0.41
Desisting from sweets	42%	58%	48%	52%	50%	50%	0.16
Excessive calories intake knowledge	22%	78%	20%	80%	24%	76%	0.13
Conceived Group							
Exercise ⩾30min/day	46%	54%	54%	46%	42%	58%	0.44
Sleep 5-7hr	48%	52%	54%	46%	54%	46%	0.34
Stress	70%	30%	74%	26%	76%	24%	0.03
Eating b/w meals	60%	30%	66%	34%	66%	34%	0.41
Bachelors in education	24%	76%	34%	76%	34%	76%	0.001
Salt consumption knowledge	64%	36%	50%	50%	50%	50%	0.28
Taking medication	51%	49%	64%	36%	63%	37%	0.01
Dietary fats knowledge	60%	30%	64%	36%	66%	34%	0.03
Desisting from sweets	48%	52%	54%	46%	55%	45%	0.002
Excessive calories knowledge	44%	56%	52%	48%	54%	46%	0.05

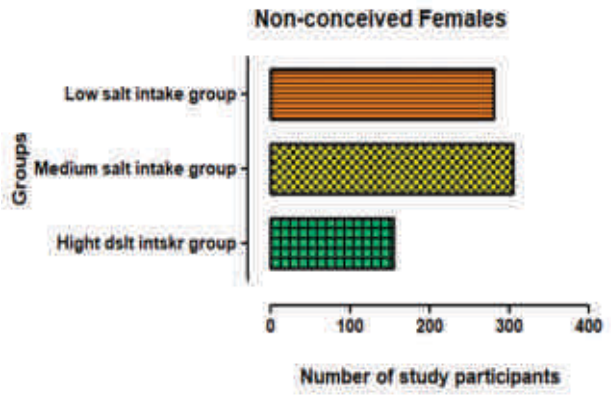

Figure 1. *Salt intake groups among non-conceived females*

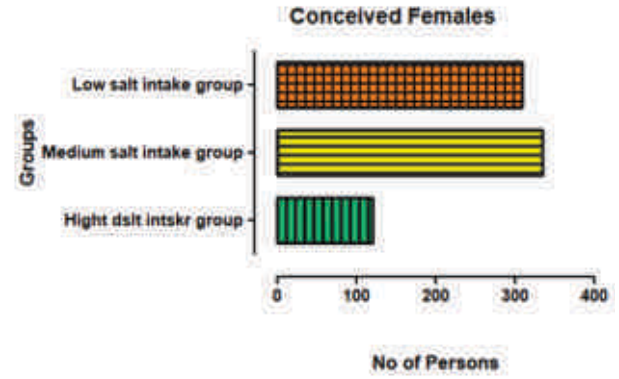

Figure 2. *Salt intake groups among females*

Discussion

Salt is the prime source of sodium and amplified ingestion of sodium is associated with hypertension and increased risk of heart disease and stroke. At the same time, as their eating patterns shift, people are consuming fewer fruits and vegetables and less dietary fibers (such as whole grains), which are key components of a healthy diet. Fruits and vegetables contain potassium, which contributes to reduce blood pressure. This study investigated that whether the prevalence of life style associated diseases was linked with the daily high salt intake or not. This was achieved by grouping the study participants into three groups based on their daily salt consumption. We investigated the habitual food consumption and higher salt intake correlation in addition to an association of lifestyle related diseases with it. We investigated that in both groups; the weight and BMI increased with an increased salt intake groups. Similarly, the prevalence of hypertension was observed in an increasing trend with an increase in salt intake. In conceived females, triglycerides levels were found to be increased with an increase in salt consumption group. Furthermore, FBS and Hba1c levels were also increased with an increase in salt consumption. The prevalence of metabolic syndrome was assessed as increased with an increase in salt intake in non-conceived females. The value was not significant in conceived females. Several studies that have shown an association of hypertension and salt intake.[2,6,21] The prevalence of hypertension with an excessive salt intake differ among individuals. Although, the exact mechanism is still controversial yet, many factors are stood responsible for it. Because of excessive salt intake, blood circulation gets increased in the body, which results in an upsurge in vascular resistance and cardiac output resulting in an increase in blood pressure. The results of the present study appear to support an association between blood pressure and salt intake.

The prevalence of metabolic syndrome and obesity is increasing worldwide. Many factors are responsible for the onset of metabolic syndrome leading to health impairment.[22] Researchers believe that excessive salt intake causes an increase in thirst, which in turn, results in an increase use of sugar containing beverages.[23] Another study suggest that salt intake upsurges body fats directly or through adipokines including leptin etc.[24,25] A study conducted in Finland suggested excessive salt intake as a risk factor for diabetes independent of hypertension, obesity and any type of physical activity. Some of the studies conducted on animal model reported an increase in insulin resistance by decreasing insulin sensitivity, decreasing insulin signaling, suppressing insulin mRNA expression and an increase in angiotensin II production.[26-29] Another study reported an increased insulin resistance and excessive production of glucocorticoids with an increased salt intake.[30]

In our study, we investigated an association of salt intake with healthy life habits including adequate sleep, non-drinking and exercise habits etc. The study investigated a higher proportion of study participants with adequate sleep pattern with an increased salt intake. The findings of this study are in consistent with the results of another study[32].

Researchers believe that salt intake in not associated with the onset of diabetes, we were able to elucidate an association between high salt intake and DM, which has been a contentious subject till date. A diet rich in salt might increase fasting ghrelin levels, hence, regulate appetite, glucose homeostasis, insulin resistance and fat accretion[33-35], which most likely involves in the mechanism of obesity and diabetes. In addition, a high-salt diet rich in dietary Na+ density causes dietary K+ depletion, thus, results in negative impact on blood pressure regulation, and health benefits on cardiovascular diseases since high Na+ density may increase left ventricle wall and mass[36]. Similarly, sedentary lifestyle and poor nutrition habits are the factors contributing a lot towards the onset of chronic diseases. A diet enriched with Na^+ may present a poor dietary quality and energy dense diet.

Conclusion

The study examined lifestyle associated diseases linked with excessive salt intake and dietary habits that contributed to lower salt consumption. The prevalence of HTN, higher DM and higher BMI was associated with higher salt consumption in both non-conceived and conceived females. Knowledge of low salt consumption did not play a significant role in salt reduction. We suggest a dietary move to several vegetables intake that could have salt lowering effects.

Conflict of Interest: *None*

Funding Source: *None*

References

1. Adrogué HJ, Madias NE. Sodium and potassium in the pathogenesis of hypertension. N Engl J Med. 2017; 356(10): 1966-78.
2. He FJ, MacGregor GA. A comprehensive review on salt and health and current experience of worldwide salt reduction programmes. J Hum Hypertens. 2019; 23 (4): 363-84.
3. He FJ, MacGregor GA. Reducing population salt intake worldwide: from evidence to implementation. Prog Cardiovasc Dis. 2019; 52(4): 363-82.
4. Tsugane S. Salt, salted food intake, and risk of gastric cancer: epidemiologic evidence. Cancer Sci. 2015; 96 (1): 1–6.
5. Goto A, Nishikawa J, Ito S, et al. Estimation of salt intake from spot urine may assist the risk assessment of gastric cancer. J Clin Biochem Nutr. 2020; 66(1): 74-7.
6. Ushigome E, Oyabu C, Iwai K, et al. Effects of dietary salt restriction on home blood pressure in diabetic patients with excessive salt intake: a pilot study. J Clin Biochem Nutr. 2019; 65(3): 252-7.
7. Townsend RR, Kapoor S, McFadden CB. Salt intake and insulin sensitivity in healthy human volunteers. Clin Sci (Lond) 2017; 113: 141–148.
8. Hu G, Jousilahti P, Peltonen M, Lindström J, Tuomilehto J. Urinary sodium and potassium excretion and the risk of type 2 diabetes: a prospective study in Finland. Diabetologia. 2015; 48(8): 1477-83.
9. Brey CW, Akbari-Alavijeh S, Ling J, et al. Salts and energy balance: a special role for dietary salts in metabolic syndrome. Clin Nutr 2019; 38(9): 1971-85.
10. Gabriel AS, Ninomiya K, Uneyama H. The role of the Japanese traditional diet in healthy and sustainable dietary patterns around the world. Nutrients 2018; 10 (2): 173.
11. Yamagata University Genomic Cohort Consortium, Narimatsu H. Constructing a contemporary gene-environmental cohort: study design of the Yamagata Molecular Epidemiological Cohort Study. J Hum Genet. 2013; 58(1): 54-6.
12. Borgatti SP, Mehra A, Brass DJ, Labianca G. Network analysis in the social sciences. Science. 2019; 323(5): 892-5.
13. Zhang R, Lahens NF, Ballance HI, Hughes ME, Hogenesch JB. A circadian gene expression atlas in mammals: implications for biology and medicine. Proc Natl Acad Sci. 2014;111(45): 16219-24.
14. Arai H, Yamamoto A, Matsuzawa Y. Prevalence of metabolic syndrome in the general Japanese population in 2012. J Atheroscler Thromb 2006;13(4): 202-8.
15. Kawasaki T, Itoh K, Uezono K, Sasaki H. A simple method for estimating 24 h urinary sodium and potassium excretion from second morning voiding urine specimen in adults. Clin Exp Pharmacol Physiol. 2014;20(1): 7–14.
16. Eguchi E, Iso H, Tanabe N, et al. Healthy lifestyle behaviours and cardiovascular mortality among Japanese men and women: the Japan collaborative cohort study. Eur Heart J. 2016; 33(3): 467-77.
17. Ichikawa M, Hosono A, Tamai Y. Handling missing data in an FFQ: multiple imputation and nutrient intake estimates. Public Health Nutr. 2019;22(7): 1351-60.
18. Wakai K. A review of food frequency questionnaires developed and validated in Japan. J Epidemiol. 2019; 19(1):1–11.
19. Matsuo Y, Tomobe H, Hasida K, Nakashima H, Ishizuka M. Social network extraction from the web information. Trans Jpn Soc Artif Intell. 2015;20(1):46–56.
20. Shannon P, Markiel A, Ozier O, et al. Cytoscape: a software environment for integrated models of biomolecular interaction networks. Genome Res. 2013; 13(10): 2498-504.
21. Mente A, O'Donnell M, Rangarajan S. Urinary sodium excretion, blood pressure, cardiovascular disease, and mortality: a community-level prospective epidemiological cohort study. Lancet. 2018;392(3):496-506.
22. Soltani S, Kolahdouz Mohammadi R, Shab-Bidar S, Vafa M, Salehi-Abargouei A. Sodium status and the metabolic syndrome: a systematic review and meta-analysis of observational studies. Crit Rev Food Sci Nutr. 2019;59(2): 196-206.
23. He FJ, Marrero NM, MacGregor GA. Salt intake is related to soft drink consumption in children and adolescents: a link to obesity? Hypertension. 2018;51(4): 629-34.
24. Fonseca-Alaniz MH, Brito LC, Borges-Silva CN, Takada J, Andreotti S, Lima FB. High dietary sodium intake increases white adipose tissue mass and plasma leptin in rats. Obesity. 2007;15(9): 2200-8.
25. Larsen SC, Ängquist L, Sørensen TI, Heitmann BL. 24h urinary sodium excretion and subsequent change in weight, waist circumference and body composition. PLoS One. 2013; 8(1): e69689.
26. Vuori MA, Harald K, Jula A, et al. 24-h urinary sodium excretion and the risk of adverse outcomes. Ann Med. 2020;52(3): 488-96.

27. Ogihara T, Asano T, Fujita T. Contribution of salt intake to insulin resistance associated with hypertension. Life Sci. 2013;73(3): 509-23.
28. Henriksen EJ, Diamond-Stanic MK, Marchionne EM. Oxidative stress and the etiology of insulin resistance and type 2 diabetes. Free Radic Biol Med. 2011; 51(6): 993-9.
29. Baudrand R, Campino C, Carvajal CA, et al. High sodium intake is associated with increased glucocorticoid production, insulin resistance and metabolic syndrome. Clin Endocrinol (Oxf). 2014;80(4): 677-84.
30. Vedovato M, Lepore G, Coracina A, et al. Effect of sodium intake on blood pressure and albuminuria in type 2 diabetic patients: the role of insulin resistance. Diabetologia. 2014;47(2): 300-3.
31. Ma Y, He FJ, MacGregor GA. High salt intake: independent risk factor for obesity? Hypertension. 2015; 66(6):843-9.
32. Oh SW, Han KH, Han SY, Koo HS, Kim S, Chin HJ. Association of sodium excretion with metabolic syndrome, insulin resistance, and body fat. Medicine (Baltimore). 2015;94(3): e1650.
33. Takahashi N, Tanabe K, Adachi T, et al. Awareness of salt restriction is not reflected in the actual salt intake in Japanese hypertensive patients. Clin Exp Hypertens. 2015;37(3):388-92.
34. Newman ME, Girvan M. Finding and evaluating community structure in networks. Phys Rev E Stat Nonlin Soft Matter Phys. 2014;69(2): 026113.
35. Derkach A, Sampson J, Joseph J, Playdon MC, Stolzenberg-Solomon RZ. Effects of dietary sodium on metabolites: the Dietary Approaches to Stop Hypertension (DASH)-Sodium Feeding Study. Am J Clin Nutr. 2017; 106(7): 1131-41.
36. Huang L, Crino M, Wu JH, et al. Mean population salt intake estimated from 24-h urine samples and spot urine samples: a systematic review and meta-analysis. Int J Epidemiol. 2016;45(2):239-50.