 doi:10.20944/preprints201611.0089.v1

Article

Estimation of the Daily Salt Intake by 24-Hour Urinary Sodium Excretion in Morocco: A Pilot Study

Abdelfettah Derouiche, Younes El-Kardi *, Karima Mohtadi and Ali Jafri

Research Unit of Human Nutrition, Research Laboratory of Biology and Health (URAC34), University Hassan 2 Casablanca, Casablanca 20100, Morocco; afderouiche@gmail.com (A.D.); karimamohtadi90@gmail.com (K.M.); ali.jafri@outlook.com (A.J.)

* Corresponding author: elkardi.younes@hotmail.fr

Abstract: **Introduction:** Hypertension is a serious public health problem in Morocco. The objective of this pilot study was to estimate the salt intake of Moroccan adults by measuring 24-hour urinary sodium excretion. **Methods:** 132 participants were recruited from the central region of Morocco. Sodium, potassium and creatinine levels were measured using the 24-hour urine samples. Additional data included anthropometric measurements and socio-demographic questionnaire. **Results:** The daily sodium, potassium and creatinine excretions were 2779.1±1334.9 mg, 1350.0±642.8 mg and 820.3 ± 381.2 mg, respectively. Data analysis revealed that 71.2% of the participants had a daily sodium intake more than 2000 mg (5g of salt) recommended by the WHO. The mean of potassium excretion was 1350.0±642.8 mg /day, this average was lower than 3.51g per day recommended by the WHO. **Conclusion**: Public health measures to reduce sodium and increase potassium consumption in order to decrease the population's risk of high blood pressure and heart disease are recommended.

Keywords: hypertension; salt intake; urinary excretion; Morocco

 doi:10.20944/preprints201611.0089.v1

Background:

High salt consumption may predispose individuals to high blood pressure and increase the risk of non-communicable diseases; especially cardiovascular diseases [1–3]. In a recent study, it has been estimated that 1.65 million cardiovascular deaths in 2010 could be attributed to the high salt consumption [4]. According to World Health Organization (WHO) , cardiovascular diseases (CVD) will become the leading cause of Disability Adjusted Life Years (DALYs) in 2020 [5] and more significantly, 80% of this global burden will occur in low and middle income countries [6].

Reduction of sodium intake has been established as a lifestyle change which is recommended to reduce cardiovascular diseases (CVD) mainly by decreasing blood pressure (BP) level [7,8]. Thus, WHO has recommended salt reduction as a top priority to prevent Non-Communicable Diseases and has considered this a public health target [9].

In Morocco, the prevalence of hypertension in adults was estimated to 33.6 % in 2000 [10]. More recently, the WHO estimated the prevalence of hypertension in Morocco in 2008 to 41.2 % [5], and 34 % of CVD in 2014 [11].

The exact average amount of salt consumption in Morocco remains unknown. But, given the adverse impact of excessive salt consumption on health and particularly on blood pressure levels and cardiovascular diseases, WHO-EMRO has recommended a research project to estimate the sodium intake in Morocco and in other countries in the region of the East Mediterranean. Therefore, the aim of this pilot study was to measure 24-hour urinary sodium excretion in order to estimate the salt intake in the central region of Morocco.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 17 November 2016 doi:10.20944/preprints201611.0089.v1

Methods:

Sample

A total of 132 participants (64 men and 68 women) were recruited from the central region of Morocco characterized by a varied climate and ethnicity of their population. Participants were healthy adults aged between 24 and 64 years with no history of renal disease.

Data collection:

The individual information of the participants was collected using a socio-demographic questionnaire. Sodium and potassium intake were estimated by measuring 24-hour urinary sodium and potassium excretion. Samples have been collected between March and June 2014. Similar temperatures were recorded during the period of this study. Verbal instructions were given to the participants for the 24-hour urine collection; The first urine of the day was discarded and all urine over the following 24 hours was collected in 5 liters plastic containers (with 1g of boric acid) [12].

Body weight was measured using Omron body composition monitors (BF511) and Height was measured using SECA stadiometer for all the participants. Body Mass Index (BMI) was calculated and used to determine the anthropometric status of the participants. Blood pressure (BP) was recorded 3 times for each participant.

Urinary biochemical testing: Sodium, potassium and creatinine were measured by dry chemistry methods using Vitros 250 Chemistry System (Ortho Clinical Diagnostics). All the analyses were realized in a certified laboratory. Urinary creatinine was measured to discard incorrect urine collection.

Statistical analysis: Statistical analysis was done using CDC's statistical package Epi Info version 7. Data were described as means ± standard deviation for continuous variables. One-way ANOVA was used to compare the data means between both genders. Statistical significance level was set at $\alpha = 0.05$.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 17 November 2016 doi:10.20944/preprints201611.0089.v1

Results:

A total of 128 participants accepted to collect their 24-hour urine samples. The mean age of the participants was 44 ± 12, range 24–65 years. The mean ages were 47 ± 11 years and 43 ± 12 years for men and women respectively **(table 1).** Ten samples were discarded from the analysis due to incorrect urine collection. Otherwise, the mean urine volume was 1125.5 ± 553.0 milliliters (n=118) with a range of (520-3300 ml). Our results showed that 34.11% of the participants were overweight (BMI between 25 and 30) and 20.93% were obese (BMI > 30) **(table 2**).

Table 3 shows 24-hour urine excretion of sodium, potassium, creatinine and Na/K ration were particularly higher in men than in women. The mean of sodium excretion was 2779.1±1334.9 mg/day, which 1428.8±799.9 mg/day in men and 1325.0±437.9 mg/day in women. Data showed that 71.2% of the participants had intakes of over 5 g of salt (NaCl)/day (2000 mg of Na/day recommended). Moreover, the general average of potassium excretion was 35.04 ± 16.57 mEq/day.

No significant differences were observed between men and women **(Table 1).**

Discussion:

24-hour urinary sodium excretion is regarded as the best way to measure sodium intake of an individual [13]. Thus, alternative dietary methods have mostly been used in studies of the relation between sodium intake and cardiovascular disease.

This pilot study showed that mean values of 24 h urinary sodium excretion for all participants was 2779 ± 1377 mg (120 mEq ± 58), which 2928 ± 1227 mg in men (range 1058–6613 mg) and 2640 ± 1427 mg in women (range 392–6431 mg), that is higher than 2000 mg/day recommended by WHO for males and females (2000 mg/day) [14].

However, salt consumption was estimated considering all sodium ingested as NaCl [15] because the 24-hour urinary sodium excretion can estimate 85–90% of dietary intake of sodium from all sources. In our report, urinary salt excretion was 6.95 g/day; however if the approximately 15%

 doi:10.20944/preprints201611.0089.v1

non-renal loss [16] were to be included, the overall salt intake would be 8.11 g/day. Moreover, our data showed that 71.2% of participants had a daily salt intake more than 5 g NaCl/day, and only 28.8% that are below the WHO recommendation of 5g/day [17]. Also, the daily individual average of bread consumption in Morocco is about 500 g [18] which is the equivalent of a daily intake of 8 to 9 g of salt through bread alone [19].

Our data showed that 24-hour mean excretion of potassium was 1350 ± 642 mg (35 mEq ± 16), which indicates that potassium intake was low in both sexes of this sample (1429 ± 800 mg and 1325 ± 438 mg in men and women respectively), which could only amplify the burden of disease to which contributes the high sodium consumption [20].

As another study [21], we found that Na^+ and K^+ excretions were higher in men than in women, which confirms observations in other countries [22,23], that the intake of sodium is higher than the daily recommendations while potassium is below them, 2 g and 3.51 g, respectively [17,24].

Furthermore, potassium has been recognized as a protective factor for hypertension and a proposed modifier of the association between sodium intake and CVD [25]. Moreover, high potassium intake may have the greatest effect when salt intake is high, and it was associated with a lower risk of death and cardiovascular events [26].

Recently, it has been reported that high intake of sodium is not associated with higher BP in people who have an increased intake of potassium [27]. Our results showed that Na/k ratio was 4 times higher in this sample than what is recommended by WHO [28] which could mean a higher cardiovascular risk for this population. A Chinese study found that the Na/k ratio was 3 times higher than recommendation, and they found that Na/K ratio has a stronger association with hypertension than does sodium or potassium intake alone [29].

Several epidemiological reports have shown a relationship between sodium and potassium intake and cardiovascular disease and mortality in the general population [22,30]. In this study, we found

 doi:10.20944/preprints201611.0089.v1

that urinary sodium excretion was higher than WHO recommendation, which could participate at the hypertension prevalence in Morocco [5].

Studies have estimated that decreasing salt intake from 10 g to 5 g per day would reduce overall stroke rate by 23% and CVD by 17% [31]. A recent meta-analysis has reported a small salt reduction of 2.0–2.3 g/day was associated with a 20% decrease in cardiovascular events [32].

Efforts should be invested in raising awareness about the dangers of a diet rich in sodium and about strategies to reduce salt intake in Morocco.

Conclusion:

The high sodium intake alongside with the low potassium intake reported in this study could both contribute to the high prevalence of hypertension, CVD, stroke and CHD in Morocco. Thus, reducing sodium should be a priority on the public health strategy agenda in Morocco. Strategies should include intensive public education by emphasizing; salt reduction during cooking and at the table and by evaluating and monitoring the population sodium and potassium consumption and sources in the diet. There is a need for concerted action from government, civil society, public health experts, academia, and food and beverage industries.

Competing interests:

Authors declare that they have no competing interests.

What is already known on this topic?

High salt consumption may predispose individuals to high blood pressure

In Morocco, the prevalence of hypertension in adults was estimated to 33.6 % in 2000

Reduction of sodium intake has been established as a lifestyle change which is recommended to reduce cardiovascular diseases

What this study adds?

Our data showed that 71.2% of participants had a daily salt intake more than 5 g NaCl/day, and only 28.8% that are below the WHO recommendation of 5g/day.

 doi:10.20944/preprints201611.0089.v1

Our data showed that 24-hour mean excretion of potassium was 1350 ± 642 mg (35 mEq ± 16), which indicates that potassium intake was low than recommendation

Reducing sodium should be a priority on the public health strategy agenda in Morocco.

Authors' contributions

Abdelfettah Derouiche, Younes El-Kardi and Ali Jafri reviewed and revised the manuscript. Younes El-Kardi and Ali Jafri wrote the manuscript and carried out statistical analysis. Abdelfettah Derouiche, Younes El-Kardi, Ali Jafri and Karima Mohtadi performed the study. Abdelfettah Derouiche coordinated the study. All authors read and approved the final manuscript.

Acknowledgements:

Authors acknowledge the assistance of the local authorities and the contribution and commitment of the participants.

Ethics approval and consent to participate:

Ethical approval: This study was approved by the Ethics Committee for Biomedical Research in Casablanca, Morocco (Reference: 21/14).

In this study we have obtained a statement of consent for all participants.

Funding:

This study was financed by Eastern Mediterranean Regional Office of the WHO (EMRO-WHO).

References:

1. He FJ, MacGregor GA. Salt, blood pressure and cardiovascular disease. Curr Opin Cardiol. 2007;22(4):298–305.

2. Kotchen T a, Cowley AW, Frohlich ED. Salt in Health and Disease — A Delicate Balance. N Engl J Med. 2013;368:1229–37.

3. McCarron D a. Dietary sodium and cardiovascular and renal disease risk factors: Dark horse or phantom entry? Nephrol Dial Transplant. 2008;23:2133–7.

4. Mozaffarian D, Fahimi S, Singh GM, Micha R, Khatibzadeh S, Engell RE, et al. Global Sodium Consumption and Death from Cardiovascular Causes. N Engl J Med. 2014;371(7):624–34.

5. WHO. Global status report on noncommunicable diseases: Description of the global burden of NCDs, their risk factors and determinants. 2010;176.

6. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancet. 2004;364(9438):937–52.

7. Bibbins-Domingo k. Projected effect of dietary salt reductions on future cardiovascular disease. N Engl J Med. 2010;362:590–9.

8. He FJ, MacGregor GA. How far should salt intake be reduced? Hypertension. 2003;42(6):1093–9.

9. WHO. Global action plan for the prevention and control of noncommunicable diseases 2013-2020. 2013.

10. Tazi M, Abir-Khalil S, Chaouki N, Cherqaoui S, Lahmouz F SJ. Prevalence of the main cardiovascular risk factors in Morocco: results of a National Survey, 2000. J Hypertens. 2001;21(5):897–903.

11. WHO. Noncommunicable Diseases (NCD) Country Profiles. 2014;

12. WHO-EMRO. How to obtain measures of population level sodium intake in 24-h urine samples. 2013;(October).

13. Elliott P. Observational studies of salt and blood pressure. Hypertension. 1991;17(1 Suppl):3–8.

14. WHO. Strategies to monitor and evaluate population sodium consumption and sources of sodium in the diet. Geneva (CHE): WHO. 2010.

15. Mill JG, Silva ABT da, Baldo MP, Molina MCB, Rodrigues SL. Correlation between sodium and potassium excretion in 24- and 12-h urine samples. Brazilian J Med Biol Res. Brazilian Journal of Medical and Biological Research; 2012;45(9):799–805.

16. Ovesen L, Boeing H. The use of biomarkers in multicentric studies with particular consideration of iodine, sodium, iron, folate and vitamin D. Eur J Clin Nutr. 2002;56 Suppl 2:S12–7.

17. WHO. Guideline: Sodium Intake for Adults and Children. Geneva: World Health Organization. 2012.

18. Mokhtar N, Belhadj H, Kress D, Zerrari A, Chaouki N, Aguenaou and H. Food-fortification program in Morocco. Food Nutr Bull. 2001;22(4):427–31.

19. Derouiche A, Jafri A, El-Kardi Y, Jabari M, Habbal R, El-Attaoui K AM. Should bread be targeted as a vector to reduce sodium intake in Morocco ? PrePrints. 2014;

20. Mozaffarian D, Pischon T, Hankinson SE, Rifai N, Joshipura K, Willett WC, et al. Dietary intake of trans fatty acids and systemic inflammation in. Am J Clin Nutr. 2004;79:606–12.

21. Ortega RM, López-Sobaler AM, Ballesteros JM, Pérez-Farinós N, Rodríguez-Rodríguez E, Aparicio A, et al. Estimation of salt intake by 24 h urinary sodium excretion in a representative sample of Spanish adults. Br J Nutr. 2011;105:787–94.

22. Yang Q, Liu T, Kuklina E V, Flanders WD, Hong Y, Gillespie C, et al. Sodium and potassium intake and mortality among US adults: prospective data from the Third National Health and Nutrition Examination Survey. Arch Intern Med. 2011;171(13):1183–91.

23. Donfrancesco C, Ippolito R, Lo Noce C, Palmieri L, Iacone R, Russo O et al. Excess dietary sodium and inadequate potassium intake in Italy: results of the MINISAL study. Nutr Metab Cardiovasc Dis. 2013;23:850–6.

24. WHO. Guideline: Potassium Intake for Adults and Children. Geneva: World Health Organization. 2012.

25. Koliaki C, Katsilambros N. Dietary sodium, potassium, and alcohol: key players in the pathophysiology, prevention, and treatment of human hypertension. Nutr Rev. 2013;71(6):402–11.

26. Aaron KJ, Sanders PW. Role of Dietary Salt and Potassium Intake in Cardiovascular Health and Disease: A Review of the Evidence. Mayo Clin Proc. 2013;88(9):987–95.

27. Rodrigues SL, Baldo MP, Machado RC, Forechi L, Molina MDCB, Mill JG. High potassium intake blunts the effect of elevated sodium intake on blood pressure levels. J Am Soc Hypertens. 2014;8(4):232–8.

28. WHO. WHO Forum on Reducing Salt Intake in Populations Report of a WHO forum and technical meeting, 5–7 October 2006, Paris, France. Geneva, Switzerland: World Health Organization. 2007.

29. Du S, Neiman A, Batis C, Wang H, Zhang B, Zhang J, et al. Understanding the patterns and trends of sodium intake, potassium intake, and sodium to potassium ratio and their effect on hypertension in China1-3. Am J Clin Nutr. 2014;99:334–43.

30. Umesawa M, Iso H, Date C, Yamamoto A, Toyoshima H, Watanabe Y, et al. Relations between dietary sodium and potassium intakes and mortality from cardiovascular disease: the Japan Collaborative Cohort Study for Evaluation of Cancer Risks. Am J Clin Nutr. 2008;88(1):195–202.

31. Cook NR, Cutler JA, Obarzanek E, Buring JE, Rexrode KM, Kumanyika SK, et al. Long term effects of dietary sodium reduction on cardiovascular disease outcomes: observational follow-up of the trials of hypertension prevention (TOHP). BMJ. 2007;334(7599):885–8.

32. He FJ, MacGregor GA. Salt reduction lowers cardiovascular risk: meta-analysis of outcome trials. Lancet (London, England). 2011;378(9789):380–2.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 17 November 2016 doi:10.20944/preprints201611.0089.v1

Table 1: Demographic data (SD: standard deviation, BP: blood pleasure)

	Men (n = 57)	Women (n = 61)	Total (n = 118)
	Mean (SD)		
Age	47 (11)	43 (12)	44 (12)
BMI	25.00 (3.94)	28.04 (4.97)	26.57 (4.74)
Systolic BP	117 (19)	114 (15)	116 (17)
Diastolic BP	76 (9)	72 (11)	74 (10)

Table 2: Characteristics of participants (n=118)

Characteristics	%
BMI	
Underweight	1.70 %
Normal	42.37 %
Overweight	32.21 %
Obesity	23.72 %
Personal situation	
Married	78.79 %
Single	21.21 %

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 17 November 2016 doi:10.20944/preprints201611.0089.v1

Education	
None	27.27 %
Informal	14.39 %
Primary school	14.39 %
Middle school	9.58 %
High School	6.82 %
Higher education	27.27 %
Professional situation	
Public sector	23.66 %
Private sector	11.45 %
Independent	23.66 %
Student	2.29 %
Retired/Unemployed	37.40 %
Others	1.52 %

Table 3: 24-hour urine data (SD = standard deviation)

	Sodium (mg)	**Potassium (mg)**	**Creatinine (mg)**	**Na/k ratio**
Gender	**Mean (SD)**			
Men	2927.6 (1227.5)	1428.8 (799.9)	916.09 (422.63)	4.40 (2.80)
Women	2640.3 (1427.6)	1325.0 (437.9)	789.65 (389.10)	3.83 (2.19)
p-value	*0.245*	*0.161*	*0.095*	*0.224*