Original Article

Evaluation of the Adherence to Low Sodium Diet by Urinary Excretion of Sodium in Hypertensive Patients at the Yaounde General Hospital

Évaluation de l'adhérence au régime hyposodé par l'excrétion urinaire de sodium chez un groupe de patients hypertendus de l'Hôpital Général de Yaoundé

Jérôme Boombhi[1,2], Vicky Jocelyne Ama Moor[1,3], Alain Menanga[1,2], Arnaud Kamguia[1], Bâ Hamadou[1], Samuel Kingue[1,2]

[1]Department of Internal Medicine and Specialties, Faculty of Medicine and Biomedical Sciences, University of Yaounde I.
[2]Internal Medicine service, Yaounde General Hospital.
[3]Department of Physiological and Biochemical Sciences, Faculty of Medicine and Biomedical Sciences, University of Yaounde I.
[4]Biochemistry Laboratory, university hospital, Yaounde Cameroon.

Corresponding author*:*
Dr Jérôme Boombhi
Email:boombhijerome@yahoo.fr
tel: 675 81 49 13

Mots clés. Observance, régime hyposodé, hypertension artérielle

Key words. Adherence, low sodium diet, urinary excretion, hypertension, Yaounde general hospital.

ABSTRACT

Objectives. Therapeutic adherence is defined by the degree at which the patient complies with the pharmacologic and non-pharmacologic treatment. It is stratified at 3 levels: pharmacologic treatment, hygiene of life and medical follow-up. Achieving optimal blood pressure control through good adherence to low sodium diet would reduce the occurrence of complications due to hypertension. The aim of our study was to evaluate the adherence of patients with hypertension to low sodium diet, at Yaoundé general hospital. **Methods**. We conducted a cross-sectional study including 148 hypertensive patients who were on pharmacologic treatment and were being followed up at Yaounde General Hospital, from 02 January to 22 April 2016. The study variables were adherence to pharmacologic therapy by the girerd test and adherence to low sodium diet by spot urinary sodium level. Statistical analysis was carried out by the software Epi info 3.5.4.   **Results**. One hundred forty eight (148) hypertensive patients were recruited. The male/female ratio was 0.56, with the age range 46-65 years being mostly represented. 118 participants (79.7%) resided in urban areas. 96 patients (64.9%) were treated with thiazide diuretics and 85 (57.5%) had poor adherence to pharmacologic therapy. The estimated mean 24-h urine sodium was 7.76 ± 3.37 g / 24 h. Forty-seven patients had recommended salt intake (<6 g / 24 h), 92 patients (62.2%) had an inadequate salt intake and 9 (6%) patients had excessive salt intake. **Conclusion**. Adherence of hypertensive patients to low sodium diet is not satisfactory at Yaounde. Only 31, 7% of hypertensive patients comply with the low sodium diet.

RÉSUMÉ

Objectifs. L'observance thérapeutique se définit par le degré avec lequel le patient respecte les prescriptions médicamenteuses et non médicamenteuses. Elle se divise en 3 niveaux : médicamenteux, hygiène de vie, suivi médical. L'obtention d'un contrôle tensionnel optimal par le biais d'une bonne observance d'un régime hyposodé réduirait la survenue des complications de l'hypertension artérielle. L'objectif de ce travail était d'évaluer l'observance du régime hyposodé chez les patients hypertendus suivis à l'Hôpital Général de Yaoundé. **Méthodes.** Nous avons mené une étude transversale portant sur 148 hypertendus sous traitement suivis à l'hôpital général de Yaoundé du 02 janvier au 22 Avril 2016. Les données évaluées étaient: l'observance du traitement médicamenteux par le test de Girerd ; le régime hyposodé par le dosage du sodium sur spot urinaire. L'analyse statistique a été effectuée par le logiciel Epi info 3.5.4. **Résultats.** Nous avons recruté 148 participants hypertendus ; le sex ratio H/F était de 0,56 avec une prédominance de la tranche d'âge de 46- 65 ans. 118 participants (79.7%) résidaient en zone urbaine. Concernant le traitement médicamenteux, les diurétiques thiazidiques étaient la classe d'antihypertenseurs la plus retrouvée 85 (64,9%)patients   et   57 ,5 % d'entre eux avaient une mauvaise observance au traitement médicamenteux. La natriurèse moyenne estimée des 24 heures était de 7,76 ± 3,37 g/24 h. Quarante sept patients avaient une consommation de sel recommandée (< 6g/24h), 92 patients avaient une consommation inadaptée de sel (62,2%) et 9 patients (6%) une consommation excessive de sel. **Conclusion.** L'observance du régime hyposodé chez les patients hypertendus suivis à l'Hôpital Général de Yaoundé est inadéquate. Seuls 31 ,7 % des hypertendus traités respectent le régime hyposodé.

INTRODUCTION

Therapeutic adherence is defined by the World Health Organization (WHO) by the extent to which a person's behavior corresponds with recommendations from a health care provider [1]. It is stratified into 3 levels: pharmacologic treatment, lifestyle and therapeutic follow-up and evaluations in chronic diseases at 50% [2]. High blood pressure causes multiple renal, cardiovascular and neurological complications and it accounts for 9.4 million deaths annually [3]. The occurrence of complications due to hypertension could be reduced through optimal control of blood pressure which can be obtained by improving adherence to treatment. Consequently, the prevention of complications of high blood pressure through the adoption of a healthy lifestyle could constitute a financial gain for the developing countries with regard to the high cost management of hypertension. The world Health Oraganization recommend a maximum sodium intake of 5g per day for hypertensive patients [4]. In Japan, in 2002, Tanakan and al found natriuresis of 10.5 g/24h in a population of hypertensive patients [5]. In Sub-Saharan Africa and in Cameroon there is a lack of studies on adhesion of hypertensive patients to treatment [6]. To appreciate this important parameter in the follow-up of patients in our environment, we carried out a descriptive cross-sectional study on the adherence to dietary measures in general and to low sodium diet in particular. This aimed to improve the control of high blood pressure and its complications. It was done in hypertensive patients followed up at the Yaounde General Hospital.

METHODS

This was a descriptive cross-sectional study conducted over a period of four months (January to April 2016) in the outpatient unit of Cardiology of the Yaounde General Hospital and at the Laboratory of Biochemistry of the Yaounde University Hospital. Participants were recruited by consecutive sampling. Patients with hypertension receiving antihypertensive treatment and who gave their consent to participate in the study were included.

We excluded patients with comorbidities that could modify spot urinary sodium level: Chronic renal disease / acute kidney injury; any pathology that may create intra-abdominal fluid accumulation such as: intestinal occlusion, pancreatitis, peritonitis; Patient being under loop diuretics or under corticosteroids at the time of study.

Adherence to the sodium restricted diet was assessed by estimating the 24-h urinary sodium excretion in mmol/24 h.

Data was analyzed by the software Epi info version 3.5.4.

Procedure

Patients who came for medical consultation were recruited during the consultation of Cardiology.

During the first contact: the purpose, procedure, advantages and disadvantages of the study were explained to the participant. Signed informed consent was obtained.

During consultation

During the interview, the participant filled the questionnaire assisted by the investigator. For this, the patient's history was taken and information was also gotten from his medical record. The aim of this was:

- ✓ Patient identification: name, age, sex, occupation, address, marital status.
- ✓ History of hypertension: date of onset, duration, mode of discovery, complications, current medications for hypertension.
- ✓ The patient's personal medical history (diabetes, gout).
- ✓ Assessment of adherence to antihypertensive therapy by the Girerd compliance test.
- ✓ Assessment of adherence to low sodium diet by estimating 24 h urinary sodium excretion.

Daily salt intake, it was evaluated by the estimation of 24 h urinary sodium excretion.

Method of estimation of 24-hour urinary sodium excretion

We used the formula developed by Tanaka et al in 2002 in Japan to estimate 24-hour urinary sodium from a spot urine sample. [5] This formula expresses the 24-hour urinary sodium from the sodium and Creatinine measured on spot urine sample:

Estimated 24h urinary sodium (mmol/day)= $21{,}98 \times XNa^{0{,}392}$ [5]

$XNa = [(SUNa / SUCr \times 10) \times PR\ Cr]$

SUNa: Concentration of sodium measured on spot urine sample in mEq/l

SUCr = Concentration of creatinine measured on spot urine sample in mg/dl.

PRCr (mg / day) = $[(-2.04) \times age + 14.89 \times weight\ (kg) + 16.14 \times height\ (cm) - 2244.45]$

The aim of this method is to minimize or eliminate the biases related to the collection of 24-hour urine (bad collection, forgetfulness, discomfort).
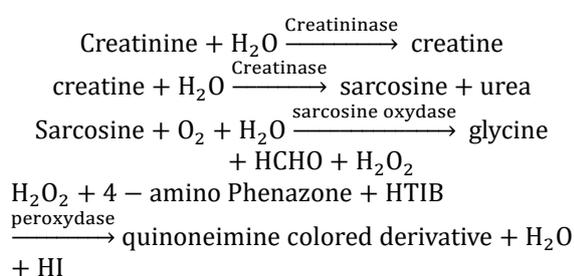
The collection of urine was done in a bottle without fixating agent during the interview. The urine samples were transported in an isothermal bag for biological analysis. Urine was centrifuged before analysis and stored at room temperature for at most 5 days.

We measured on each urine sample: the sodium concentration by the potentiometry method on electrodes specific to electrolytes and Creatinine level by the enzymatic method according to a commercial

kit CREP2. Using these two measurements, we estimated the 24h urinary sodium excretion using the formula given above; Then we divided this result (mmol/day) by 17 to obtain the amount of salt intake in g/day (1g NACL = 17mmol sodium).

Principle of the enzymatic method

The creatinine kit includes a DRI creatinine-detect test which is intended for the quantitative determination of creatinine in human urine. This test is based on the conversion of creatinine into glycine, formaldehyde and hydrogen peroxide via creatininase, creatinase and sarcosine oxidase. Under the catalytic action of peroxidase, hydrogen peroxide reacts with 4-amino Phenazone and hydroxy-3-triiodo-2,4,6-benzoic acid (HTIB) with formation of a quinoneimine colored derivative. The intensity of the staining of the developed quinoneimine chromogen is directly proportional to the creatinine concentration in the reaction mixture.

$$Creatinine + H_2O \xrightarrow{Creatininase} creatine$$
$$creatine + H_2O \xrightarrow{Creatinase} sarcosine + urea$$
$$Sarcosine + O_2 + H_2O \xrightarrow{sarcosine\ oxydase} glycine + HCHO + H_2O_2$$
$$H_2O_2 + 4 - amino\ Phenazone + HTIB$$
$$\xrightarrow{peroxydase} quinoneimine\ colored\ derivative + H_2O + HI$$

The creatine of the sample is destroyed by the action of creatininase, sarcosine oxidase (SOD) and catalase.

Measurement of spot urinary sodium using the Cobas Integra 311 ISE.

In our study, we used the ISE (Ion Selective Electrodes) model to determine the concentration of urinary sodium. It is a liquid chemical apparatus in which the reagents are contained in cassettes found inside the machine.

Its principle is based on the potentiometric measurement applied to electrodes of electrolyte. Here the dosage will be done indirectly by ISE (Ion Selective Electrodes). It uses the specific properties of the material of a membrane to create an electrical potential (electromotive force) and determine the concentration of ions in solution. The electrode has a selective membrane in contact with the solution to be analyzed and an internal filling solution. This inner filling solution contains the analyte at a constant concentration. Due to the particular nature of the membrane, the test ions are distributed on both sides of the membrane. The electromotive force of the membrane is determined by the difference in concentration of the ion tested in the analyzed solution and that of the internal solution. The EMF develops for a specific ion in solution according to the Nernst equation:

$E=E_0+RT/nF\times ln\ [(fC_t)/ (fC_i)][60]$

With: E=EMF of the electrode; $E_0 = EMF$ of the standard electrode; R= constant; T= temperature; n= charge of the ion; F= faraday constant; ln= natural logarithm (base e) ; f= activity coefficient; C_t= ion concentration in the test solution; C_i= ion concentration in the internal solution. The principle of the sodium electrodes used in this case is based on neutral charge carriers. [7] This electrode was made up of plastic (PVC).

Biological results were validated by quality control after each assay.

Physical examination

A physical examination was carried out systematically by the principal investigator.

✓ *Blood pressure*

It was measured using an OMRON M2 Basic electronic meter with an appropriate cuff in accordance with the measurement conditions. The results were recorded in millimeters of mercury (mmHg)

✓ *Heart rate*

Its measurement was made by palpating and counting the pulse for 60 seconds. Results were noted in number of heart beats/minute.

✓ *Weight*

It was noted in kilograms (Kg) and evaluated by a calibrated weighing scale. The participant being barefooted and wearing light clothing.

✓ *Height*

It was measured in centimeters (cm) using a stadiometer graded to the nearest 0.5 cm. The participant stood barefooted, with feet joint; the skull, shoulders, calves and heels applied against the vertical axis of the meter; the arms were free along the body.

✓ *Body Mass Index*

It was obtained by dividing weight by the square of the height. It is expressed in kg/m^2.

Statistical analysis:

The data were analyzed using the Epi info version 3.5.4 software. Qualitative variables were described by frequencies and proportions; the quantitative variables were expressed by the mean and the standard deviation. $p< 0.05$ was considered statistically significant.

Ethical considerations

The protocol of this study scrupulously respected the principles of medical research and was approved by the ethics and research committee of the Faculty of

Medicine and Biomedical Sciences of the University of Yaounde I.

Operational definition of terms

Hypertension: Any individual with an increase in systolic blood pressure ≥ 140 mmHg and / or diastolic blood pressure ≥ 90 mmHg; Or has been on an antihypertensive medication.

Controlled hypertension: Any patient of both sexes, known hypertensive taking antihypertensive medication, having a systolic blood pressure <140 mmhg and/or a diastolic blood pressure <90 mmhg.

Uncontrolled hypertension: Any patient of both sexes, known hypertensive, taking antihypertensive medication and having a systolic blood pressure ≥ 140 mmHg and/or a diastolic blood pressure ≥ 90 mmHg.

Obesity: individual having a BMI ≥ 30 kg/m^2

Recommended salt intake: 24 h urinary sodium excretion <6g / day. [8]

Inadequate salt intake: 24 h urinary sodium excretion between 6 -11.9 g / day [8]

Excessive salt intake: 24 h urinary sodium excretion > 12 g / day [8].

RESULTS

Socio-demographic characteristics and hypertension

Concerning socio-demographic characteristics, the prevalence of hypertension was higher in women (64.2%) than in men 35.8%. Most participants stayed in urban areas (79.7%). The age group 46 to 65 years was the most represented. (**Table I**)

Table I: Distribution of hypertensive patients according to socio-demographic characteristics

	Number	Percentage
Sex		
Male	53	35.8
Female	95	64.2
Age		
25-45 years	11	7.4
46-65 years	86	58.1
>65 years	51	34.5
Place of residence		
Urban	118	79.7
Rural	30	20.3

Adherence to antihypertensive therapy

Of the 148 hypertensive patients, 85 patients (57.5%) had adherence problems, 54 of whom had minor adherence (36.5%) and 31 (21%) were non- adherent. Sixty-three patients (42.5%) had a good adherence. (**Table II**).

Table II: distribution of patients according to adherence to antihypertensive therapy.

Adherence to antihypertensive treatment	Number	Percentage
Good adherence	63	42.5
Minor adherence	54	36.5
Non- adherence	31	21
Total	148	100

Salt intake

✓ *Measured spot urinary sodium (mmol / l)*

The mean spot urinary sodium was 92.53 ± 58.75 mmol/l. (Table III)

✓ *Estimated 24 h urinary sodium excretion (mmol/24h)*

The average 24-h urinary sodium excretion was 131.85 ± 57.45 mmol/24h equivalent to 7.76 ± 3.37 g Nacl/24h. (Table III)

In addition, 47 patients had recommended salt intake (18 controlled and 29 uncontrolled), 92 patients had inadequate salt intake (62.2%), and 9 patients had excessive salt intake (6.1%) (Table IV)

✓ *Measured spot urinary creatinine(mg/l)*

The average measured spot urinary creatinine was 1691.12±1058.88 mg/l. (**table III**)

✓ *Predictive 24h urinary creatinine (mg/24h)*

The predictive 24h urinary creatinine was averagely 1517.142±290.35 mg/24h.

Table III: Distribution of Study Population according to biological parameters

Biological parameters	Mean	Standard deviation
Measured spot urinary sodium (mmol/l)	92.53	58.75
Estimated 24h urinary Na excretion (mmol/24h)	131.85	57.45
Measured spot urinary creatinine(mg/l)	1691.12	1058.88
Predictive 24h urinary creatinine (mg/24h)	1517.142	290.35

Table IV: Distribution of Study Population by Salt intake

Salt intake (g/24h)	Number (%)
Recommended (<6g)	47 (31.7)
Inadequate (6-11.9g)	92 (62.2)
Excessive(≥12g)	9 (6.1)
Total	148 (100)

DISCUSSION

The aim of our study was to evaluate the adherence to low sodium diet in hypertensive patients on treatment. We therefore recruited 148 hypertensive patients over a period of 4 months in the outpatient department of cardiology of the Yaounde General Hospital. 47 patients (31.7%), actually respected the low sodium diet. The limitation of our study was the use of spot urinary sodium instead of 24 h urine which is more precise and validated for the evaluation of the daily salt intake.

In our study, we had a female predominance with a sex ratio of 0.56. This result is similar to that of Katchunga et al of the DR Congo who studied 284 hypertensive patients, and found a sex ratio of 1.77 [9]. Also, 79.7% of the patients lived in urban areas and 20.3% in rural areas. Katchunga et al in 2011 found a predominance of 65.5% of people living in urban areas; this predominance of the urban dwellers in our study could be explained by the fact that the site of recruitment was located in an urban area. With regards to therapeutic adherence, it is difficult to measure in routine practice, especially for chronic diseases; to simplify this, Girerd et al [8] have developed a drug adherence test which is a standardized questionnaire. Using this test, we found a proportion of 42.5% who had a good therapeutic adherence, 36.5% had minor adherence and 21% were non-compliant. Meanwhile, Pio Machihude et al in 2011 found a Therapeutic adherence rate of 16.25% with 52.34% of non-compliant patients. [6] Girerd et al found a therapeutic adherence rate of 66% in France with 10% of non-compliant patients [8]. Konin et al in Cote d'Ivoire found a good adherence rate of 12.5% with 55% non-compliant patients [10]. This disparity between the various studies shows the complexity in assessing adherence in chronic diseases in routine clinical practice. Other assessment methods such as the use of electronic pills or urinary biological assays, because of their costly nature, can not be applied in sub-Saharan Africa due to economic difficulties and the lack of universal health coverage.

Salt Intake

We used the method of spot urinary sodium to evaluate salt intake. There are several methods for evaluating salt intake, amongst which: measurement of 24-hour urinary sodium excretion. Although the gold standard in this evaluation, it has as major disadvantage that it is difficult to implementation due to the high percentage of the poor collection of 24 h Urine, due to forgetfulness and discomfort. In addition, the use of 24-hour urine collection is difficult to achieve in a routine clinical practice. To remedy these drawbacks, Tanaka et al in Japan developed a method for estimating 24-h urinary sodium excretion from a spot urine sample collected in the consultation room. The spot urinary sodium value varies; it is lower at night and higher during the day. It is also influenced by daily physical exercises and the amount of salt intake. In order to minimize urine volume, spot urinary creatinine was integrated. Tanaka's formula therefore depends on spot urinary sodium and creatinine.

In our study, the mean 24 h urinary sodium excretion was estimated at 131.85 ± 57.45 mmol/24h (7.76 g/24h). Forty-seven patients had recommended salt intake (31.8%), 92 patients had inadequate salt intake and 9 patients had excessive salt intake. Tanaka et al [5] found a 24-hour sodium urine excretion estimated at 178.9 ± 36.2 mmol/24h (10.54 g / 24h); Kawamura et al in 2006 [11] in 73 hypertensive patients on treatment obtained an estimated 24-hour urinary sodium of 7.5 g/24h. The PURE study [12] in 2003 found an average urine sodium of 12.2 g/24h of NaCl in 101,945 hypertensive patients. It should be noted that these three studies used a single morning sample to estimate salt intake. Other studies, such as Girerd et al [13] in France, found a 24-h average urine sodium of 144 mmol/day (8.5 g / day) with a low proportion of good salt intake (28, 7%) and a proportion of inadequate salt intake of 52.7%.

From the above, we can deduce that salt consumption in hypertensive patients is high in both developed and developing countries. This could be explained by the fact that the use of salt seems to be rooted in the culture; the populations were accustomed at an early age to consume a large quantity of salt.

Moreover, increasing urbanization leads to the importation of new feeding habits (ready-made food, canned food, pizzas ...); foods which are made with a large amount of salt.

CONCLUSION

In conclusion, we found that the daily salt intake was 7.76g/24h. Only 31.7% of hypertensive patients in this study respected the low sodium diet. The assessment of salt intake by spot urinary sodium should be encouraged, with the advantage of being accessible and easy to do.

REFERENCES

1. World Health Organization. Adherence to long term therapies; time for action. Genève; WHO: 2003.211p.

2. Golay A, Nguyen-Howles M, Matelcluc S, Bufacchi T, Amati F. Améliorer l'observance médicamenteuse. MédHyg 2004; 62:909-13.

3. World health Organization. World Health Day 2013: a global brief on Hypertension. CWorld health organization. 2013. 40p.

4. Chalmers J , MacMahon S, Mancia G , Whitworth J , Bellin L , Hansson et al . WHO-ISH Hypertension Guidelines Committee. 1999 World health Organization. International Society of Hypertension Guidelines for the management of hypertension J Hypertens 1999; 17: 151- 183.

5. Tanaka T, Okamura T, Miura K, Kadowaki T, Ueshima H, Nakagawa H et al. A simple Method to estimate populationnal 24-h urinary sodium and potassium excretion using a casual urine specimen. J HumHypertens .2002; 16:97-103.

6. Pio M, Baragou S, Afassinou Y, Pessinaba S, Atta B, Ehlan K et al. Observance thérapeutique de l'hypertension artérielle et ses facteurs dans le service de cardiologie du CHU Tokoin de Lomé. Pan Afr Med J. 2013. 14 :4p. Consulté le 12 février 2016. Disponible sur : http://ncbi.nlm.nih.gov.pmc/articles/PMC 3612906/.

7. Shibata Y, Maruizume T, Miyage H. Journal of Japan Chem Soc. Chemistry and Industrial Chemistry. 1992; 9: 961-967.

8. Girerd X, HanonO, Anagnostopoulos K, Ciupek C, Mourad JJ, Consoli S. Assessment of antihypertensive compliance using a self-administered questionnaire: development and use in a hypertension clinic. Press Méd 2001:21:1044-8.

9. Katchunga PB, M' Buyemba-Kayamba J-R, Masumbuko BE, Lemogoum D, Kashongwe ZM, Degaute JP et al. Hypertension artérielle chez l'adulte Congolais du sud Kivu: résultats l'étude Vitaraa .Press Med. 2011. 40(6) ; 315-323.

10. Konin C, Adoh M, Coulibaly I, Kramoh E, Safou M, N'Guetta R et al. L'observance   thérapeutique et ses facteurs chez l'hypertendu noir africain. Arch mal Cœur vaiss. 2007; 100(8):630-634.

11. Kawamura M, Kusano Y, Takahashi T, Owada M et Sugara T. Effectiveness of spot urine Method in evaluating daily salt intake in hypertensive patients taking oral antihypertensive drugs. Hypertens Res 2006; 29:397-402.

12. Mente A, O'Donnell M, Rangarajan S, Matthew J, Mc Queen, Xingyu W et al .For the PURE investigators. Association of urinary sodium and potassium excretion with blood pressure. Engl J Med. 2014; 371: 601-11.

13. Girerd X, Villeneuve F, Rosenbaum D, Gury CH, Giral Ph. Evolution de la consommation de sel chez les hypertendus vivant en ile-de- France entre 2008 et 2014. Institut E3M. Unité de prévention cardiovasculaire, groupe hospitalier Pitié-Salpêtrière .2014.1p.