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Dietary sodium and potassium intakes: Data from urban and rural areas

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ABSTRACT

Objectives: Hypertension is highly prevalent in West African populations, but little data is available on salt and potassium intake in these populations. We assumed in this study that sodium and potassium intake might be high and low, respectively, in the Beninese population in view of the emerging nutritional transition. The aim of this study was to estimate dietary sodium and potassium intakes based on 24-h urine collections.

Methods: We selected 420 individuals (ages 25–64 y), representative of the population, from urban and rural areas in Benin. Urine was collected over 24 h, and sodium, potassium, and creatinine were quantified. Blood pressure was measured on the left arm using a validated electronic oscillometric monitor.

Results: Adequate data were available for 354 participants. Mean dietary intake of sodium and potassium were 4.4 ± 2.1 and 1.8 ± 0.9 g/24 h, respectively. High intake of sodium was associated with urban area, age <44 y, administrative occupation, higher income, body mass index (BMI) ≥25 kg/m^2, and a large waist circumference. High potassium intake was associated with male sex, administrative occupation, BMI ≥25 kg/m^2, and large waist circumference. Sodium intake was associated with high systolic and diastolic blood pressures. In multivariate analysis, only age <44 y and, marginally, BMI ≥25 kg/m^2 were associated with high sodium intake, whereas male sex and a BMI ≥25 kg/m^2 were associated with high potassium intake.

Conclusion: Large proportions of the population had sodium intake higher, and potassium intake lower, than dietary recommendations. These results suggest that interventions to reduce salt consumption and promote potassium-rich foods, including fruits and vegetables, are needed in Benin.

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Introduction

Numerous studies have shown that sodium intake is associated with high blood pressure (BP), a major risk factor for cardiovascular diseases (CVDs) [1–3]. High sodium intake also is associated with renal function impairment, asthma, gastric cancer, and osteoporosis [2,3]. Conversely, consumption of potassium (e.g., fruits and vegetables) is associated with lower BP and can counteract the negative effects of sodium on BP [4,5].

Therefore, interventions to reduce sodium intake and to increase potassium intake in the population are important public health strategies to reduce the burden of CVDs in all countries [6,7]. Reducing salt intake also is a global target agreed by the World Health Organization (WHO) member states and a "best-buy" strategy [8] for the reduction of noncommunicable diseases. Thus, nutrients embedded in salt also need to be considered in nutritional advice.

The WHO recommends a daily sodium intake of <2 g, corresponding to <5 g of salt (NaCl) [2], and a daily potassium intake of ≥3.5 g [3]. Sodium and potassium intakes can be estimated based on surveys using either a dietary questionnaire or direct measurement of salt in urine, using either spot urine or, preferably, 24-h urine collection, which is the reference method to assess salt and potassium intake in individuals [9,10]. This assumes that extracellular bodily fluids equilibrate, resulting in a same electrolyte concentration in the interstitial fluid space between cells. Sodium metabolism is intimately linked to that of water [11]. However, recent evidence challenges the concept of salt-and-water homeostasis and suggests that Na^+ homeostasis cannot be maintained without additional extrarenal regulatory mechanisms. A large amount of sodium is also stored into glycosaminoglycans in skin and muscles [12].

At the population level, relatively few studies have assessed the intake of salt and potassium in Africa, and national estimates often have been derived from statistical modeling techniques using data from different countries [9,13]. Nearly no country in Africa has implemented interventions to reduce salt intake at the population level. One exception is South Africa, which has established legislation requiring the food industry to reduce the salt content of a number of manufactured food products [14].

In Benin, the prevalence of hypertension among adults aged ≥25 y was 28.7% in 2008 [15] and 36.1% in 2014 [16], but to our knowledge, no study has assessed intake of potassium and sodium in large representative samples of the population. One small study on salt and iodine intake based on 24-h urine collections was conducted in 1998 among 13 mother–child pairs: Daily salt intake was 9 g in mothers and 6 g in children aged 8 to 12 y, on average [17]. Given the high prevalence of hypertension and the emerging nutrition transition in Benin [18], it is important to regularly monitor the dietary consumption of sodium and potassium in the population to guide policies to reduce salt intake and increase potassium intake. We assumed in this study that daily sodium and potassium intakes were fairly constant during the weeks before the study, allowing for a large fraction of these ions to be excreted in the urine in this steady-state situation.

The objectives of this study were to estimate the dietary consumption of sodium and potassium in urban and rural populations in Benin based on 24-h urine collections and to determine factors associated with sodium and potassium consumption.

Methods

Study population and sampling

This was a cross-sectional study. Eligible individuals were all healthy adults aged between 25 and 64 y, residing in the city of Bohicon (total population of 113 091 inhabitants) and the rural district of Tanvè (total population of 8034), in the south of Benin [19,20]. These two areas share a similar ethnic distribution (people of the Fon ethny: 93% in Bohicon and 98% in Tanvè) and similar dietary patterns based on grains, tubers, legumes, and fish, whereas meat and dairy products, whether fresh or industrially processed, are still uncommon [21].

The study was conducted between November 2012 and September 2013. Of the 420 participants selected, 210 lived in the urban area and 210 in the rural area. A cluster sampling technique with probability proportional to size was used [22,23] with information provided by the National Institute of Statistics and Economic Analysis [24]. Thirty clusters were selected in each of the two areas. In each household, an apparently healthy man or a woman was selected alternately according to a predefined selection scheme. Eligible individuals who did not give informed consent or who had a disability (e.g., speech or understanding impediments, mental illness) or a condition that could alter salt urine collection (e.g., pregnancy or menstruation), and participants who failed to return to the health center for subsequent visits were excluded. In all, 402 individuals were included (response rate, 95.7%).

Ethics and administrative clearance

The study protocol was approved by the Ethics Committee of the Faculty of Health Sciences, University of Abomey-Calavi (Benin). Authorization to conduct the study was obtained from the Departmental Director of Health, leading physicians in the zones concerned, mayors, heads of districts, neighborhood leaders, and city authorities.

Urine sample collection

The eligible participants were asked to arrive at the health care center closest to their place of residence at 07:30 am. The start and end of the 24-h urine collection were recorded. To secure the procedure and to optimize urine collection conditions, participants rested throughout the 24-h period in the health care center. Employed participants were given a letter for their employers. A majority of participants brought their food from home; the rest bought their meals at the health care center's canteen. Participants were instructed not to change their usual eating habits.

A 5-L plastic container was given to each participant. A second container could be added if necessary. Participants were requested to report whether they had missed any urine, particularly during bowel movements (from a few drops to a significant amount of urine) and participants who missed an important urine volume were excluded (criteria explained later). Urine samples of 2 mL were taken after homogenization of the entire 24-h urine. The samples were immediately frozen at −20°C and transported in December 2013 to the Laboratory of Biochemistry and Molecular Genetics at Limoges University Hospital in France, respecting the cold chain.

Analysis of the urine samples

Urinary sodium and potassium concentrations were determined using the ion-selective electrode method [10]. Urinary creatinine was measured by the Jaffe kinetic method. All analyses were performed with an automatic analyzer Cobas (Roche, Basel Switzerland), with the module C8000 for the sodium and potassium and the module C701 for creatinine.

Creatinine excretion was used to assess the completeness of the 24-h urine collection [25] and participants were excluded from this study if 24-h creatinine was <10 mg/kg body weight for women and <15 mg/kg body weight for men, or if diuresis was <500 mL/24 h [26]. Glucosuria was measured using semi-quantitative strips (Multistix 8 SG, Siemens, Germany) and participants with positive results were excluded from this study. Participants using diuretics were also excluded [27]. Because small amounts of salt and potassium are also excreted through sweat and feces, dietary consumption of sodium and potassium estimated from urinary excretion of sodium and potassium were corrected by coefficients of 0.90 and 0.77, respectively, following standard recommendations [2,3].

Anthropometric measurements, diet, and blood pressure

Weight was measured using an electronic scale to the nearest 0.1 kg (E 753, Seca, Hamburg, Germany). Height was measured in the standing position with a measuring rod at a 0.1 cm precision using a fixed Seca stadiometer. Body mass