

## Applied nutritional investigation

## 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  $4.4 \pm 2.1$  and  $1.8 \pm 0.9$  g/24 h, respectively. High intake of sodium was associated with urban area, age <44 y, administrative occupation, higher income, body mass index (BMI)  $\geq 25$  kg/m<sup>2</sup>, and a large waist circumference. High potassium intake was associated with male sex, administrative occupation, BMI  $\geq 25$  kg/m<sup>2</sup>, 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  $\geq 25$  kg/m<sup>2</sup> were associated with high sodium intake, whereas male sex and a BMI  $\geq 25$  kg/m<sup>2</sup> 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  $\geq 3.5$  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  $\text{Na}^+$  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  $\geq 25$  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 ethnicity: 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 impairments, 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  $-20^\circ\text{C}$  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

index (BMI) was calculated as weight (kg)/height<sup>2</sup> (m<sup>2</sup>). Waist circumference (WC) was measured at a 0.1 cm precision using an inelastic tape and the World Health Organization (WHO)'s standard procedure. Abdominal obesity was defined as WC  $\geq$  102 cm in men,  $\geq$ 88 cm for women [28].

A structured semiquantitative food frequency questionnaire (FFQ) adapted from a FFQ instrument on salt developed by the George Institute (Sidney, Australia) for the WHO [29], also covering the major potential sources of potassium (fruits and vegetables, roots and tubers, cereals), was administered by trained study officers to each participant. The typical use of salt at home was also explored with questions on adding salt at the table, use of broth, and weekly frequency of consumption of foods high in salt (salty snacks, preserves, industrially conditioned meat, fish, and some traditional sources of salt). A score of salt consumption was calculated based on the weekly consumption of these items. The median frequency score was used to dichotomize low and high consumers.

Blood pressure (BP) was measured three times at 5-min intervals on both day 0 (D<sub>0</sub>) and day 1 (D<sub>1</sub>). Measurements were done on the left arm with the patient seated after a rest of  $\geq$ 5 min, using an electronic sphygmometric monitor (M6 Comfort, Omron, Japan). The cuff of the M6 monitor is adequate for both normal and large arms. Mean blood pressure at D<sub>0</sub> and D<sub>1</sub> were calculated and the average of values at D<sub>0</sub> and D<sub>1</sub> were used in this study.

#### Socioeconomic status

A socioeconomic status (SES) score was computed based on education, main occupation, and household amenities (as a proxy for income) as previously reported [30]. Two categories were considered for education and occupation, respectively: Education not exceeding primary versus postprimary education; blue collar (semi-skilled) versus white collar (skilled professionals and managers). Our household amenities score ranged from 0 to 10 [30] and was dichotomized based on the overall median score of 5. Total SES score ranged from 0 to 3 (i.e., 0 or 1 in three domains) and was further dichotomized as low (0–1) or high (2–3) based on the median score.

#### Statistical analysis

Data was analyzed using Stat-View 5.0 software (SAS Institute, Cary, NC, USA). Continuous variables were expressed as mean and SD. Categorical variables were expressed as percentage and 95% confidence interval (CI). Comparison between the variables was performed with the Student's *t* test when normality and homogeneity could be verified and using nonparametric tests otherwise (Mann–Whitney and Kruskal–Wallis tests). The associations between sodium and potassium intake values and diastolic and systolic blood pressures (DBP and SBP) were investigated using correlation coefficients. Linear regression models were performed with sodium and potassium excretion as the dependent variables after having excluded the presence of significant interactions between selected variables (sociodemographic, economic, nutritional, and BP values).

Explanatory variables with  $P < 0.20$  in univariate analyses were included in multivariate analyses.  $P < 0.05$  was considered statistically significant.

#### Results

All participants were able to collect their urine over a 24-h period. Three participants who reported to have missed only a few drops of urine during bowel movements were not excluded. Of the 402 urine samples collected, 48 results were excluded because creatinine was too low ( $n = 30$ ) [26], use of diuretics ( $n = 1$ ), glucosuria ( $n = 7$ ), or laboratory analysis problems ( $n = 10$ ). Thus, this study is based on 354 participants.

Table 1 presents the general characteristics of the study population. Mean  $\pm$  SD 24-h urinary excretions were  $4 \pm 1.9$  g for sodium and  $1.4 \pm 0.7$  g for potassium, corresponding to dietary intakes of  $4.4 \pm 2.1$  g of sodium and  $1.8 \pm 0.9$  g of potassium or, equivalently,  $11.3 \pm 5.4$  g of NaCl and  $3.7 \pm 1.8$  g of KCl. Participants with a very high salt intake (NaCl  $\geq$ 20 g/24 h;  $n = 23$ ) consumed more potassium (KCl  $4.7 \pm 2.4$  g/24 h) compared with participants with NaCl intake  $<$ 20 g/d (KCl  $2.8 \pm 1.3$  g/24 h;  $P < 0.001$ ).

A higher sodium intake was associated with living in urban versus rural areas ( $P = 0.01$ ), aged  $<$ 44 y versus  $\geq$ 44 y ( $P = 0.01$ ), administrative versus nonadministrative occupation ( $P = 0.04$ ), high versus low income ( $P = 0.008$ ), BMI  $\geq$ 25 kg/m<sup>2</sup> versus  $<$ 25 kg/m<sup>2</sup> ( $P = 0.0002$ ), and high versus normal WC ( $P = 0.009$ ). A higher potassium urinary excretion was associated with men ( $P = 0.034$ ), administrative occupation ( $P = 0.013$ ), BMI  $\geq$ 25 kg/m<sup>2</sup> ( $P = 0.034$ ), and a high WC ( $P = 0.035$ ; Table 2). Sodium urinary excretion was correlated with both SBP and DBP ( $P = 0.008$  and  $0.015$ , respectively; Fig. 1). Both SBP and DBP were correlated with ratio of Na/K ( $r = 0.14$ ,  $P = 0.0003$ ;  $r = 0.12$ ,  $P = 0.0011$ , respectively).

Multivariate linear regression analyses using sodium and potassium excretions as dependent variables are presented in Tables 3 and 4, respectively. Only age  $<$ 44 y was positively associated with high sodium intake (coefficient = 1.93, 95% CI, 0.85–3.00;  $P < 0.0001$ ) and BMI  $\geq$ 25 kg/m<sup>2</sup> was marginally significant after including BP, sex, age, BMI, rural/urban region,

**Table 1**  
Characteristics of the study sample

Variables	Number	Frequency (%)	Mean $\pm$ SD	Urinary excretion Mean $\pm$ SD	Consumption Mean $\pm$ SD
Age (y)	354		43.0 $\pm$ 11.3		
Sex	354				
Men	172	48.5			
Women	182	51.4			
BMI (kg/m <sup>2</sup> )	354		24.3 $\pm$ 4.9		
Waist circumference (cm)					
Men	172		84.6 $\pm$ 11.5		
Women	182		86.3 $\pm$ 11.9		
SBP mean (mm Hg)	354		129 $\pm$ 22		
DBP mean (mm Hg)	354		79 $\pm$ 16		
Urine volumes (L)*	354			2.8 $\pm$ 1.2	
Creatinine (mg/L)*	354			629.1 $\pm$ 403.5	
NaCl (g)*	353			10.2 $\pm$ 4.9	11.3 $\pm$ 5.4
Na (g)*	353			4.0 $\pm$ 1.9	4.4 $\pm$ 2.1
KCl (g)*	354			2.9 $\pm$ 1.4	3.7 $\pm$ 1.8
K (g)*	354			1.4 $\pm$ 0.7	1.8 $\pm$ 0.9
NaCl/KCl	354		3.9 $\pm$ 2		
Na $<$ 2 g*	29	8.2			
Na $\geq$ 2 g*	324	91.7			
K $\geq$ 3.5 g*	23	6.5			
K $<$ 3.5 g*	331	93.5			

BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure

NaCl and KCl in mEq can be expressed in g/L using the formulae 1 mEq  $\times$  1/17 for NaCl and 1 mEq  $\times$  1/13 for KCl

\* 24-h mean values.

**Table 2**  
Distribution of urinary excretions of NaCl and KCl according to selected variables

Variables	NaCl (g/24 h)			KCl (g/24 h)	
	Number	Mean ± SD	P	Mean ± SD	P
Zone			0.010		0.373
Rural	184	9.55 ± 4.54		2.93 ± 1.34	
Urban	170	11.01 ± 5.3		2.92 ± 1.61	
Sex			0.780		0.034
Male	172	10.33 ± 5.09		3.10 ± 1.61	
Female	182	10.18 ± 4.88		2.76 ± 1.32	
Age (y)			0.010		0.105
<44	180	10.92 ± 5.01		2.99 ± 1.38	
≥44	174	9.56 ± 4.87		2.86 ± 1.57	
Level of education			0.330		0.195
≤ Primary	234	10.07 ± 4.96		2.85 ± 1.50	
> Primary	120	10.61 ± 5.01		3.07 ± 1.42	
Occupation			0.040		0.013
Nonadministrative	255	9.91 ± 4.97		2.80 ± 1.45	
Administrative	99	11.12 ± 4.94		3.23 ± 1.50	
Income			0.008		0.141
Low	219	9.56 ± 4.76		2.83 ± 1.50	
High	135	11.37 ± 5.14		3.07 ± 1.44	
Socioeconomic status			0.09		0.140
Low	245	9.95 ± 4.97		2.85 ± 1.48	
High	109	10.92 ± 4.95		3.10 ± 1.45	
Body mass index (kg/m <sup>2</sup> )			0.0002		0.034
<25	230	9.54 ± 4.77		2.80 ± 1.45	
≥25	124	11.57 ± 5.12		3.15 ± 1.50	
Waist circumference			0.009		0.035
Normal	263	9.85 ± 4.84		2.83 ± 1.45	
High	91	11.42 ± 5.22		3.20 ± 1.53	
Food rich in sodium			0.794		0.046
Low	13	9.90 ± 3.17		3.31 ± 0.78	
High	340	10.27 ± 5.05		2.91 ± 1.50	
Food rich potassium			0.980		0.990
Low	293	10.26 ± 4.91		2.92 ± 1.45	
High	61	10.24 ± 5.34		2.92 ± 1.60	
Systolic blood pressure			0.130		0.280
Normal	270	10.03 ± 4.77		2.92 ± 1.36	
≥140 mm Hg	84	10.96 ± 5.58		2.92 ± 1.82	
Diastolic blood pressure			0.260		0.370
Normal	278	10.10 ± 4.83		2.92 ± 1.35	
≥90 mm Hg	75	10.82 ± 5.51		2.94 ± 1.87	
Mean SBP	354		0.008		0.790
Mean DBP	354		0.015		0.820

DBP, diastolic blood pressure; SBP, systolic blood pressure

and SES as covariates. For potassium, male sex (coefficient = 0.41, 95% CI, 0.08–0.75;  $P = 0.013$ ) and BMI  $\geq 25$  kg/m<sup>2</sup> (coefficient = 0.44; 95% CI, –0.09 to 0.79;  $P = 0.014$ ) were positively associated after adjustment for the same covariates.

## Discussion

To the best of our knowledge, this is the first study to assess intake of sodium and potassium in urban and rural populations in Benin based on 24-h urine collections. Our main findings are a high sodium intake and a low potassium intake in both rural and urban settings.

Based on WHO recommendations [2,3], almost all respondents had a high intake of sodium and a low intake of potassium. This suggests the presence of one or several sources of salt in the usual diet, an important addition of salt during cooking or at the table, or a combination of both. This is consistent with the traditional use in Benin of salty condiments and seasoning when cooking foods at home or at the table. This also can reflect an increasing consumption of industrially manufactured food products and a low consumption of fruits and vegetables in the population. The low potassium intake in this study is consistent with results of the STEPS (STEPwise Approach

to Surveillance) survey conducted in Benin, which reported that 78% of adults had low fruit and vegetable intakes at the national level in 2008 [31]. This low potassium intake also could be partly explained by the traditional cooking technique to use large volumes of water to blanch vegetables first and the cooking water being discarded, causing a loss of potassium.

Sodium excretion was higher in urban than rural areas. This is likely due to a larger access to manufactured foods and fast food in the former, consistent with emerging nutritional transition in Beninese cities, with corresponding greater access to food items rich in salt, sugar, and fat, as previously reported [18]. The larger urinary excretion of sodium and potassium in men than women is consistent with other salt studies [32–35] and could be partly explained by larger energy intake in men than women.

Intake of sodium and potassium did not markedly differ according to SES, although excretion of sodium and potassium tended to be higher in individuals of higher than lower SES (Table 2). This is consistent with a higher intake of salt in individuals of higher than lower SES observed in many low- and middle-income countries [30,36] and in high-income countries [37], which is likely due to persons of high SES having greater access to manufactured and fast foods usually rich in salt. However, recent evidence suggests that salt consumption tends

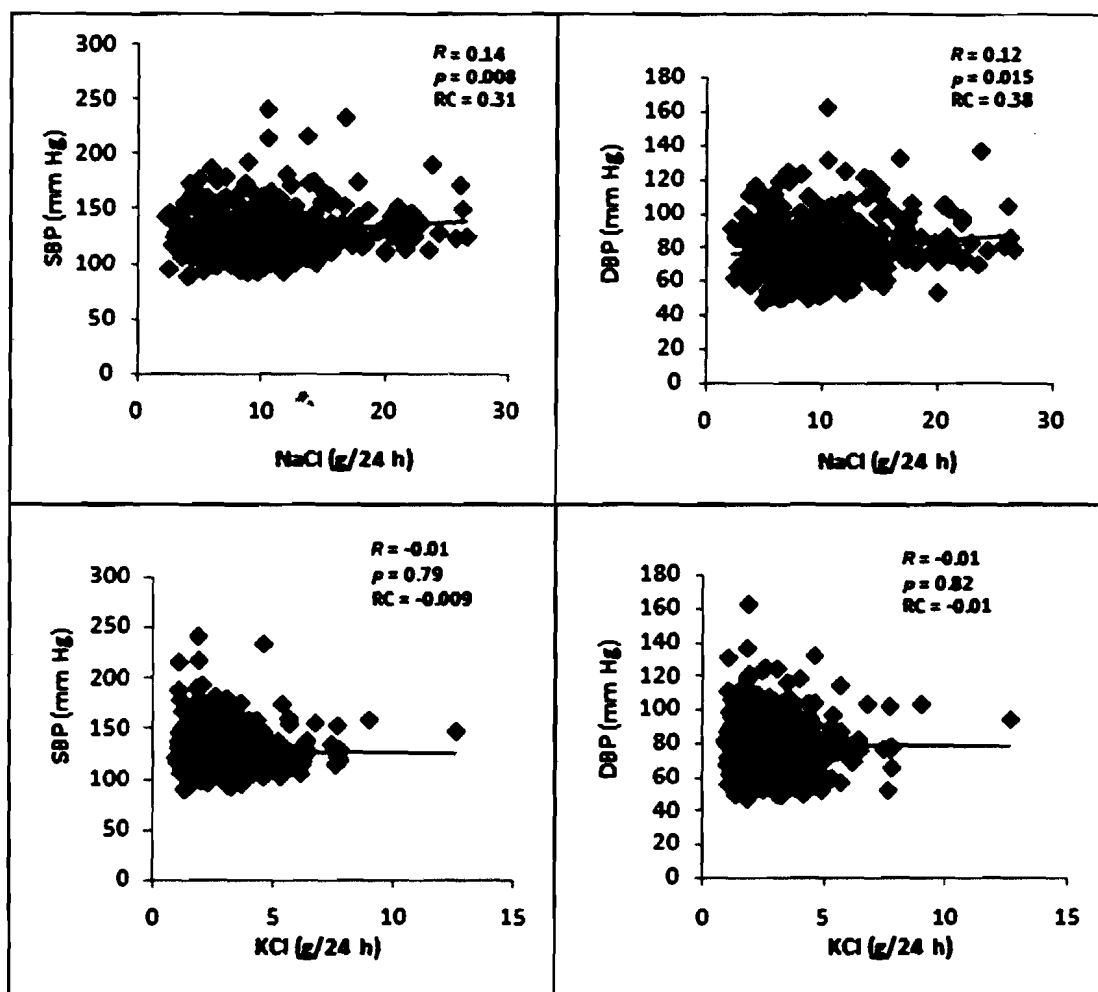


Fig. 1. Correlation between NaCl and KCl and SBP and DBP. DBP, diastolic blood pressure; RC, regression coefficient; RC, regression coefficient; SBP, systolic blood pressure.

to be lower in individuals of higher SES in some developed countries [38–41], whereas the opposite is still true in many low- and middle-income countries.

We found no significant association between urinary sodium excretion, respectively potassium excretion, and reported intake of sodium- or potassium-rich foods, respectively. This may be due to the fact that dietary information provided by participants is not accurate or because the FFQ had low sensitivity to detect food items rich in salt or potassium. This is also consistent with the fact that salt and potassium are found in many food items.

The higher consumption of sodium and potassium in overweight versus lean individuals can relate to the higher overall energy intake (i.e., larger food consumption) in the former than the latter, as suggested by many studies [32,42].

The positive correlation between sodium intake and SBP and DBP is consistent with many studies [6,32,43].

Finally, sodium intake was higher in younger than older persons, possibly related to a higher consumption of foods rich in salt (e.g., junk food) in the former than the latter. Potassium intake was also lower in women than men, and in lean versus overweight persons. Although these differences were not large, this suggests that interventions to reduce salt and to promote fruit and vegetables consumption might need to be tailored differently according to these population subgroups.

The limited number of studies of sodium and potassium intake in sub-Saharan Africa [44] allows only limited comparison of our results with other countries in the African region. It was estimated in 2010 that sodium intake in Africa was  $<3.3$  g (8.2 g of salt) [13], but this study was based on statistical modeling techniques relying on data from only very few countries in the region. In South Africa, one study reported in 2005 a urinary excretion of salt of 7.8 g/24 h [45]. In Nigeria, urinary excretions of NaCl and KCl were, respectively,  $11.4 \pm 5.3$  g/24 h and  $5.6 \pm 2.3$  g/24 h in a rural population ( $N = 400$ ) [46]. In 2013, salt consumption among medical students in Angola was  $14.2 \pm 5.1$  g/d [47]. In Seychelles, the consumption of salt was around 6 g/d based on 24-h collection in 2000, possibly because the staple diet of the population was based on unsalted rice and fish at this time [48].

The results of the present study support the need for interventions in Benin to reduce the salt content in foods (e.g., through limiting the content of salt in manufactured foods such as bread or other salt-rich food items, and through education programs to encourage people to decrease their voluntary intake of salt in their diet). Additionally, the present study further supports the need to promote the consumption of products rich in potassium, especially fruit and vegetables, a strategy that also inherently results in lower salt and high potassium intakes.

**Table 3**  
Univariate and multivariate associations between sodium intake and selected variables

NaCl (g/24 h)	Univariate			Multivariate		
	Coefficient*	95% CI	P value	Coefficient	95% CI	P value
Sex						
Men	0.15	−0.89 to 1.19	0.781	0.55	−0.60 to 1.70	0.348
Age (y)						
<44	1.36	0.32–2.40	0.010	1.93	0.85–3.00	<0.0001
Zone						
Urban	1.46	0.42–2.50	0.006	1.01	−0.20 to 2.22	0.102
Socioeconomic status						
High	0.97	−0.15 to 2.09	0.091	−0.39	−1.75 to 0.96	0.566
Body mass index (kg/m <sup>2</sup> )						
≥25	2.03	0.95–3.10	<0.0001	1.43	−0.043 to 2.91	0.057
Food rich in Na						
High	0.36	−2.40 to 3.14	0.794			
Food rich in K						
High	−0.01	−1.40 to 1.38	0.988			
SBP mean	0.31	0.08–0.54	0.008	0.40	−0.11 to 0.91	0.129
DBP mean	0.38	0.07–0.70	0.015	−0.15	−0.84 to 0.54	0.665

DBP, diastolic blood pressure; SBP, systolic blood pressure

\* Regression coefficient.

Dietary interventions at the population level are key measures to reduce the incidence of hypertension and CVD, and they require both educational programs and structural interventions in multiple sectors, as advised in the 2013–2020 WHO Global Plan of Action for the Prevention and Control of Noncommunicable Diseases [8].

There are limitations in our study. The collection of 24-h urine on several days would have produced more accurate sodium and potassium measurements [49] given the day-to-day variability of sodium and potassium intakes. However, this was not possible in view of the limited resources. A second limitation is that dietary consumption was not measured in detail based on dietary questionnaires, mainly because no dietary questionnaire has been validated in Benin. It is well known, however, that nutrient quantification based on self-reported data is highly inaccurate and prone to several biases, which further emphasizes the need to rely on 24-h urine collections when assessing salt or potassium consumption. Third, we advised participants to abstain from going to work on the day of urine collection to facilitate their 24-h urine collection and to spend the day at health care center. Although most participants brought food from home for their meals, this might have altered the participants' dietary

habits, although it is not easy to anticipate the direction and the magnitude of systematic biases that can have altered our salt and potassium intake estimates. Finally, in the absence of standard values for daily urinary creatinine excretion in black populations, we used the references considered in a study of salt intake in a US multiracial population [26].

The strengths of this study are the fairly large sample size ( $N = 354$ ) and the population-based design. These results provide the first epidemiologic data on sodium and potassium consumption at the population level in a region of Benin. Further studies should assess salt and potassium contents of frequent food items to guide the implementation of regulations on food content of selected foods (e.g., bread), adequate food labeling, and related education programs.

## Conclusion

Salt intake is high, and potassium intake is low, in Benin. These findings are important in view of the high prevalence of hypertension and the emerging nutrition transition in Benin. The results will be useful to guide the development of national policies to control salt and potassium in manufactured foods, of

**Table 4**  
Univariate and multivariate associations between potassium intake and selected variables

KCl (g/24 h)	Univariate			Multivariate		
	Coefficient*	95% CI	P value	Coefficient	95% CI	P value
Sex						
Men	0.34	0.03–0.64	0.031	0.41	0.08–0.75	0.013
Age (y)						
<44	0.13	−0.17 to 0.44	0.391	0.14	−0.15 to 0.45	0.341
Zone						
Urban	−0.01	−0.32 to 0.29	0.934			
Socioeconomic status						
High	0.25	−0.08 to 0.58	0.140	−0.004	−0.37 to 0.36	0.980
Body mass index (kg/m <sup>2</sup> )						
≥25	0.34	0.02–0.67	0.035	0.44	0.09–0.79	0.014
Foods rich in Na						
High	−0.39	−1.22 to 0.42	0.343			
Foods rich in K						
High	−0.001	−0.41 to 0.40	0.99			
SBP mean	−0.009	−0.07 to 0.06	0.792			
DBP mean	−0.01	−0.10 to 0.08	0.829			

DBP, diastolic blood pressure; SBP, systolic blood pressure

\* Regression coefficient.

adequate food labeling, and of related awareness programs. Additional studies should further monitor salt and potassium intake in the population over time and quantify the main dietary sources of sodium.

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