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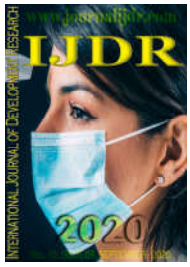

RESEARCH ARTICLE | OPEN ACCESS

ESTIMATION OF URINARY SODIUM EXCRETION BY TANAKA AND KAWASAKI EQUATIONS IN AFRO-DESCENDANTS

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ABSTRACT

Objective: To evaluate the mean urinary sodium excretion and its difference by sex by Kawasaki and Tanaka equations in an isolated urine sample in afro-descendants from Alcântara-MA. **Material and Method:** Cross-sectional study, conducted between August 2012 and August 2013, with collection of demographic, socioeconomic, lifestyle, blood pressure measurement, blood and urine samples. **Results:** Female predominance 51.20%, men were younger 31.57% and 74.78% had less than eight years of schooling, 99.56% belonged to social classes D and E. 56.11% received less than one minimum wage, 10.89% smoked and 53.01%, (p-value <0.001), did not consume alcohol or had stopped. The mean urinary sodium excretion in an isolated sample for the Kawasaki equation was 203.2 mmol/L ± 84.9 mmol/L and 150.7 mmol/L ± 47.3 mmol/L for the Tanaka equation. The difference in the estimation of sodium excretion between both was 52.5 mmol/L ± 40.5 mmol/L. **Conclusion:** In this study, the Kawasaki equation presents higher mean excretion values when compared to the Tanaka equation; however, the Tanaka equation tends to underestimate the mean excretion value for men.

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INTRODUCTION

Worldwide, most populations have an average sodium intake that exceeds what is considered optimal. In 2010, the world average sodium intake based on ingestion analysis in 66 countries was estimated at 3.95g per day [1]. In countries with a western-style diet, 75% of the intake comes from processed foods. In Brazil, the average consumption of Brazilians is 11.4 g per day of salt [2]. In Maranhão, a study that evaluated a specific population of Quilombola origin in the city of Alcântara identified consumption of 11.4g per day of sodium, surpassing by more than twice the recommendation of the World Health Organization (WHO), which is a maximum of 2g per day of sodium or 5g per day of salt in adults [3]. High sodium intake is associated with several chronic diseases, including systemic arterial hypertension and chronic kidney disease (CKD) [2]. These diseases affect an important portion of the black population. According to data from the Brazilian Institute of Geography and Statistics (IBGE), more than half of the Brazilian population is composed of blacks or *pardo* people, of whom 75% are among the poorest. In 2015, 12.8% of blacks and *pardo* people reached the higher education, despite the influence of affirmative action policies. The research also reveals that black and *pardo* people are more likely to live in precarious conditions, without access to water, sewage and garbage collection [4]. People with African ancestry with hypertension are two to three times more likely to develop chronic kidney disease and five times more likely to progress to the final stage kidney disease, when compared to whites [5]. The precise evaluation of sodium intake by the population is a difficult task, because the available methods have limitations. In this sense, 24-hour urine collection is widely considered as the gold standard method for ingestion assessment and for comparing and validating other evaluation methods [6]. Although 24-hour urine is the most reliable method, it involves a considerable burden on participants, which can influence response rates in population-representative surveys. Thus, the use of a single particular urine collection has many advantages, especially in population-based studies [7]. Studies developed by Tanaka [8] and Kawasaki [9] proposed formulas to estimate sodium excretion through predictive equations for 24-hour creatinine and sodium excretion. These equations have already been validated for the Brazilian population [10].

Predictive equations estimate creatinine excretion predicted for 24h (CrPr24h) from age, weight and height, with the same equation for both sexes in Tanaka's study [8]. Kawasaki [9] developed sex-specific equations. As a result of the persistence of racial disparities, blacks have a higher incidence of diseases and die earlier, at all ages and considering that, from an ethnic point of view, African descendants represent the second largest group of the Brazilian population. The evaluation of urinary sodium excretion may allow risk screening for chronic non-communicable diseases, thus contributing to the planning of more effective measures aimed at guiding, preventing and promoting health in the afro-descendant population. The aim of this study is to evaluate the levels of urinary sodium excretion and their difference by sex in urine sample isolated by the Kawasaki and Tanaka equations.

MATERIALS AND METHODS

This study is part of a larger study entitled Prevalence of chronic kidney disease in the city of Alcântara, State of Maranhão, Brazil "PREVRENAL". This cross-sectional study evaluated the estimation of urinary sodium excretion in afro-descendants. To calculate the sample size, in order to determine the mean value of urinary sodium excretion of PREVRENAL, a pilot with 76 afro-descendants of the population studied was performed. Assuming a mean sodium excretion rate of 211.4 mmol/day, standard deviation of 71.4 mmol/day and a sampling error of 7 mmol/day, a sample size of 810 individuals was obtained. Considering possible losses, the sample was increased by 10%, totaling 1,162 individuals, who were selected by a random probabilistic sampling process in two stages, with the first census tract represented by the Quilombola communities, and the second by the household. Inclusion criteria were individuals of both sexes aged ≥ 18 years, located in each census tract selected. All individuals from each household drawn in the established age group and who agreed to participate signed the Informed Consent Form (IC). Form study did not include individuals < 18 years ≥ 60 years, pregnant women, patients with chronic consumptive disease (cancer or acquired immunodeficiency syndrome), hematological, autoimmune diseases, systemic or genitourinary tract infection, chronic and/or acute kidney disease in dialysis therapy, and those using immunosuppressive drugs or thyroid disorders based on clinical history and physical examination. Data collection was performed from August 2012 to August 2013 and occurred in two stages. The first stage of the study consisted of data collection at home, through interviews from a structured form with questions related to demographic, socioeconomic, lifestyle information, past diseases, use of health services and blood pressure measurement. To assess the economic condition, the monthly family income was considered, according to the number of minimum wages and the Brazil Economic Classification Criterion (CCEB), built to define the classes in the metropolitan regions of the country. The CCEB divides the population into seven classes: B1 and 2, B1 and 2, C, D and E, from the best to worst level [11]. The subjects' schooling was categorized as ≤ 8 years and > 8 years of completed study.

Blood pressure (BP) was measured in the right arm of the individual, who was seated, at rest for at least five minutes, using digital sphygmomanometer (Omron®705-IT, Japan). Three measurements were performed, obtaining the mean. For BP classification, the VI Brazilian Guidelines on Hypertension were used [2]. In the second stage, urine and blood were collected. The blood sample was used to measure creatinine (Cr), glycaemia (FG), albumin, triglycerides (TG), total cholesterol (TC) and fractions (LDL-c, HDL-c), urea. After collection, the blood was centrifuged and, like urine, was packed in thermal boxes at low temperature. The biological material was analyzed in a reference laboratory following PREVRENAL's standardized methodology [12]. The renal function was evaluated by serum creatinine and estimated glomerular filtration rate (GFR) by the equation proposed by the study Chronic Kidney Disease Epidemiology (CKD-EPI): RFGe (ml/min/1.73 m²) = 141 × min (serum creatinine/κ, 1)α × max (serum creatinine/κ, 1)-1,209 × 0.993 Age × 1,018 if women – 1,159 if black. Where: κ = 0.7 for women and 0.9 for men; α = - 0.329 for women and - 0.411 for men; min indicates the minimum serum creatinine or 1; and max indicates the maximum serum creatinine or 1 [13]. Considering that the current definition of CKD requires confirmation of reduced glomerular filtration rate (GFR) (≤60 ml/min/1.73m2) for a period ≥ 3 months, the individuals with GFR ≤60 ml/min/1.73m2 in the first evaluation, after three months, were submitted to new collection for the second evaluation and diagnosis [14]. Urinary sodium excretion was estimated by Kawasaki sex-specific equation [15] and Tanaka equation [8], already validated in Brazil and described below. From the predicted creatinine (CrPre24h) and the sodium/creatinine ratio in the casual urine (NaUr), the total sodium content in the 24-hour urine (Na24h) was estimated. Tanaka equations [8]: CrPr24h (mg) = [(14.89 x weight, kg) + (16.14 x height, cm) (2.04 x age, years)] - 2,244.45; NaUr (mEq) = [In casual urine, mEq/L/(Cr casual urine, mg/dL x 10)] x CrPr24 h (mg); Estimation of Na24h excretion (mEq) = 21.98 x NaUr0.392.

Kawasaki equations [9]: Men (CrPr24h (mg) = [(15.12 x weight, kg) + (7.39 x height, cm) (12.63 x age, years)] 79.9); Women (CrPr24h (mg) = [(8.58 x weight, kg) + (5.09 x height, cm) (4.72 x age, years) – 74.95); NaUr (mEq) = [In casual urine (mEq/L) / (Cr casual urine mg/dL X 10)] x CrPr24h (mg); Estimation of Na24h excretion (mEq) = 16.3 X (√[(NaUr) x (CrPr24h)]. The collected data were analyzed and the qualitative variables are presented as frequencies and percentages and quantitative ones as mean and standard deviation (mean ± SD) or median (P25-P75), stratified by sex. The Shapiro Wilk test was used to verify the normality of the quantitative variables. For the variables of study that did not present normal distribution, the Mann-Whitney test was used to compare the variables of interest by sex, and the Wilcoxon test was used to evaluate the difference between the estimation of sodium excretion by the Kawasaki and Tanaka equations. In all statistical tests, the level of significance adopted was 5% to reject the null hypothesis; the analyses were made in the STATA software Program (Version 14.0, Stata Corporation, College Station, Texas). Complying with the requirements of Resolution 466/2012 of the National Health Council for researches involving human beings, this project was approved by the Research Ethics Committee at the University Hospital of the Federal University of Maranhão, under Opinion N. 13.942/ 2012.

RESULTS

The study sample consisted of 1,162 participants, 51.20% were women, men were younger, 31.57% were in the age group 18-29 years, 74.78% had less than eight years of schooling and 99.56% belonged to classes D and E, received less than one minimum wage, 99.56%. Regarding smoking, the prevalence was 10.89% and 53.01% reported not consuming alcohol, p-value <0.001 (Table 1). Concerning clinical and laboratory characteristics, male afro-descendants had higher mean systolic blood pressure (SBP), (131.64 ± 19.03) p-value <0.001 and little significant difference in diastolic blood pressure (76.50 ± 11.66) p-value 0.985. Women had higher mean values of FG (104.63 mg/dL ± 36.08 mg/dL), TC (201.83 mg/dL ± 49.06 mg/dL), LDL-c (125.54 mg/dL ± 40.32 mg/dL) and TG (129.41 mg/dL ± 84.66 mg/dL), while men had lower HDL-c levels (50.86 mg/dL ± 20.03 mg/dL).

Table 1. Distribution of variables according to socioeconomic characteristics of afro-descendants in Alcântara. MA, Brazil, 2013

Variable	Total n (%)	Male n (%)	Female n (%)	p-value
Age (years)				0.320
18-29	360.00 (30.98)	179.00 (31.57)	181.00 (30.42)	
30-39	279.00 (24.01)	137.00 (24.16)	142.00 (23.86)	
40-49	285.00 (24.53)	145.00 (25.57)	140.00 (23.53)	
50-59	238.00 (20.48)	106.00 (18.70)	132.00 (22.19)	
Color				0.579
White	121.00 (10.42)	55.00 (9.70)	85.00 (14.29)	
Black and *Pardo* people	1034.00 (88.98)	509.00 (89.77)	505.00 (84.87)	
Others	7.00 (0.60)	3.00 (0.53)	5.00 (0.84)	
Schooling (years)				0.027
≥ 8 years	480.00 (41.85)	143.00 (25.22)	235.50 (39.56)	
< 8 years	682.00 (59.15)	424.00 (74.78)	359.50 (60.44)	
CCEB				0.802
B	3.00 (0.26)	0.50 (0.09)	31.00 (5.21)	
C	128.00 (11.02)	2.00 (0.35)	1.00 (0.17)	
D and E	1031.00 (88.72)	564.50 (99.56)	563.00 (94.62)	
Income (minimum wages)				0.010
< 1	650.00 (56.11)	332.00 (58.56)	361,50 (60.75)	
> 1 - ≤ 2	432.00 (37.01)	203.00 (35.80)	205.50 (34.54)	
> 2	80.00 (6.88)	32.00 (5.64)	28.00 (4.71)	
Smoking				<0.001
Yes	121.00 (10.89)	38.50 (7.22)	37.00 (6.22)	
No / quit	1.041. 00 (89.11)	528.50 (92.78)	558.00 (93.78)	
Alcohol consumption				<0.001
Yes	546.00 (46.99)	331.50 (58.47)	136.00 (22.86)	
No / quit	616.00 (53.01)	235.50 (41.53)	459.00 (77.14)	

CCEB: Brazil Economic Classification Criterion.

Table 2. Distribution of variables according to clinical and biochemical characteristics, by sex, in afro-descendants from Alcântara – MA, 2013

Variable	Total	Male	Female	*p* value
SBP mmHg	129.65 ± 21.49	131.64 ± 19.03	127.66 ± 23.53	<0.001
DBP mmHg	76.85 ± 11.66	76.50 ± 11.66	77.20 ± 11.65	0.927
Fasting glycaemia (mg / dL)	103.35 ± 32.28	102.06 ± 27.92	104.63 ± 36.08	0.985
Total Cholesterol (mg / dL)	191.00 ± 46.09	180.06 ± 40.03	201.83 ± 49.06	<0.001
HDL-c mg/dL	49.18 ± 17.33	47.50 ± 13.90	50.86 ± 20.03	<0.001
LDL-c mg/dL	117.36 ± 38.41	109.11 ± 34.49	125.54 ± 40.32	<0.001
Triglyceride	124.65 ± 80.55	119.87 ± 75.95	129.41 ± 84.66	0.0131
Creatinine	0. 75 ± 0.19	0.85 ± 0.145	0.65 ± 0.18	<0.001
CKD-EPI	105.86 ± 18.94	104.90 ± 17.92	106.81 ± 19.86	0.009

Data are presented as mean ± SD. SBP: Systolic blood pressure. DBP: Diastolic blood pressure. HDL-c: High density lipoprotein-cholesterol. LDL-c: Low density lipoprotein-cholesterol. CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration (formula).

Table 3.Difference between the estimated sodium excretion using the Kawasaki and Tanaka equations, by sex, in afro-descendants from Alcântara– MA, 2013

Estimated sodium excretion	Total n=1164	Male n= 569	Female n=595	*p* value
Kawasaki Equation	203.20 ± 84.90	204.80 ± 77.90	201.70 ± 9110	0.780
Tanaka Equation	150.70 ± 47.30	144.60 ± 77.90	156.60 ± 51.10	0.503
Dif	52.50 ± 40.50	60.20 ± 36.90	45.10 ± 42.30	
p-value	<0.001	<0.001	<0.001	

Renal function, when assessed by creatinine, showed higher values for men (0.85 mg/dL ± 0.145 mg/dL). However, the glomerular filtration rate estimated by the CKD-EPI equation was higher in women (106.81 ± 19.86). (Table 2). The mean urinary sodium excretion in isolated urine sample was (203.2 mmol/L ± 84.9 mmol/L) for Kawasaki equation and (150.7 mmol/L ± 47.3 mmol/L) for Tanaka equation. The difference in the estimation of urinary sodium excretion between both was (52.5 mmol/L ± 40.5 mmol/L) and p-value <0.001. Nevertheless, the difference in mean urinary excretion measured by the Kawasaki equation was greater in males (60.2 mmol/L ± 36.9 mmol/L) p-value <0.001 (Table 3).

DISCUSSION

Vulnerable conditions were identified in this study upon finding that the population predominantly belonged to the worst social classes D and E, with worse incomes and low schooling. These data are similar to a study conducted in Bahia in a Quilombola population that observed 82.6% of the individuals inserted in the same classes and 44.3% did not have constant income [16]. Low income and schooling tend to generate health vulnerabilities, and these are usually related to black populations, linked to this, these communities also experience social insecurity, having an unsatisfactory level of care and lack of public services [16,17]. The sample of this study was predominantly young, with individuals aged 18-29 years, with a similar distribution between men and women. Studies conducted with vulnerable populations observed a larger sample share in the same age group [16,17,18]. Considering the SBP levels, men continued to have higher averages, 127.61 ± 19.51 mmHg. These findings corroborate those found in a Quilombola population in Bahia- Brazil, which obtained similar blood pressure levels, a significant percentage of individuals expressed borderline values, 23.64%, or were already considered hypertensive, 17.45% [19]. Higher blood pressure levels in men may be associated with the fact that men are less careful with health and seek less health services when compared to women [20].

In the present study, mean levels of total cholesterol above desirable were observed. Women had a much higher value compared to men, 201.83 mg/dL ± 49.06 mg/dL for 180.06 mg/dL ± 40.03 mg/dL. These values represent a higher risk of developing cardiovascular diseases for women. Total cholesterol and LDL-c, when too high, can induce or cause stenosis in blood vessels by limiting blood flow through atheroma plaques, thus increasing the risk of heart attack or cerebrovascular accident [21]. LDL-c values were also higher than desirable. Women had higher values, 125.54 mg/dL ± 40.32 mg/dL. The HDL-c was within the desirable values for both sexes, with a general mean of 49.18 ± 17.33 mg/dL.). Findings in Quilombola women in Maranhão, with similar characteristics, identified levels of TC, LDL-c and HDL-c similar to this study [22]. Dyslipidemia is a significant risk factor for heart disease and should be seen as a focus in primary and secondary prevention. However, women remain undertreated compared to men and receive fewer evidence-based therapies, including cholesterol control [23]. Regarding renal function, the GFR estimated by the CKD-EPI equation was within normal range. However, women had higher glomerular filtration than men. Research conducted in West Africa that evaluated the glomerular filtration rate estimated by the CKD-EPI equation in the population aged under 30 years also observed that women had higher GFR than men, 111.0 ± 14.5 mL/min/1.73m2 vs 104.3 ± 13.5 mL/min/1.73m2 [24]. The average daily sodium intake of the study participants, estimated from the average of the formulas, was 4.67 g/day for Kawasaki and 3.47 g/day for Tanaka (data not shown). This consumption corresponds to a daily average of salt consumption between 8 and 12 g/day, which is considered high, since it exceeds by more than twice the WHO recommendations of 5 g/day of salt, equivalent to 2 g/day of sodium [10, 25]. In relation to the estimation of urinary sodium excretion, we observed that the Kawasaki equation presented higher values when compared to the Tanaka equation. The total difference between both was 52.5 ± 40.5 mmol/L, however, in men, this difference was more pronounced, 60.2 ± 36.9 mmol/L, in women, the difference was 45.1 ± 42.3 mmol/L.

A study conducted in the Japanese population found higher urinary sodium excretion values of 246.1 ± 66.8 mmol/day for Kawasaki equation and 183.7 ± 39.0 mmol/day for Tanaka equation. Nevertheless, it is worth mentioning that this population is different and has different life habits from the population studied [26]. Despite the high values of sodium intake evidenced in this study, this is similar to that reported for the Brazilian population, which is approximately 4.5 g/day of sodium, corresponding to 11.4 g/day of salt [27]. It is also in line with the world average, obtained in 66 countries, which is 3.95g/day of sodium or 9.87 g/day of salt [28]. Recent results of an investigation with a South African population, which compared the values of urinary sodium excretion by the Kawasaki and Tanaka equations, observed that the sodium intake measured by the Kawasaki equation was 5.68 ± 2.9 g/day and by the Tanaka, 4.23 ± 1.78 g/day, values higher than the findings of this study [29]. It is well established in the literature that high sodium intake is commonly associated with several chronic diseases, and, among the main ones are systemic arterial hypertension and chronic kidney disease [2]. Research developed in the Brazilian population described a strong association between sodium and blood pressure, in which consumption above 2 g/day tends to raise blood pressure [10, 30]. In the Brazilian population, these formulas were validated, and the authors concluded that Kawasaki and Tanaka formulas tended to overestimate creatinine/sodium excretion, especially when Kawasaki formula is applied to men. However, in women, Kawasaki's formula showed better accuracy. Tanaka's formula underestimates consumption in men and determines a small overestimation in women [10]. The strengths of the present study include the great representativeness of the sample, random selection of participants and addressing a vulnerable population. This was the first population-based study conducted in afro-descendant communities of Maranhão and Brazil that evaluated sodium excretion. As important limitation of the study is its cross-sectional nature and the non-use of the gold standard in the measurement of sodium excretion. Nevertheless, it used equations already validated in Brazil.

Conclusion

Afro-descendants belonged to a young age group, with low income and schooling, being part of the worst social classes. The Kawasaki equation showed higher values of sodium excretion for men when compared to the Tanaka equation, however, the Tanaka equation tended to underestimate the excretion values for men. These findings suggest that the measurement of sodium excretion is an important monitoring datum because it is simple and inexpensive, and can be incorporated into clinical practice as a prevention measure. From this perspective, the health care of populations considered vulnerable is a challenge for the work of health teams. It is noteworthy that, although health professionals identify individuals and groups in greater situation of vulnerability and their conditioning factors, whether at the individual, social or programmatic level, they still face difficulties and limitations in the care directed to these populations in the hospital, outpatient, and public health sectors.

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