The Role of Energy Intake in the Relation between Sodium and Cardiovascular Function in Young Adults

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Abstract

Excess sodium is one of the leading causes of cardiovascular disease (CVD) risk. The current sodium guideline is <2,300 milligrams per day. This is based on absolute sodium consumption, regardless of an individual's size or energy needs. Unfortunately, it is difficult for many people to meet these recommendations. More recent evidence suggests sodium density, or sodium intake relative to calorie intake, may be a better predictor of CVD risk than absolute sodium intake. The relation between sodium density and nontraditional CVD risk factors, such as endothelial function, has not been explored. Our study is a secondary analysis of a previous cross-sectional study. Healthy young adults (age: 24±4 years, n=16) completed 3+ day diet records, which were analyzed to determine average sodium and energy intakes. Seated blood pressure (BP) measurements were taken, and endothelial function was measured via brachial artery flow-mediated dilation (FMD). The relation between absolute sodium intake and sodium density (mg sodium/kcal) and BP and FMD were examined using Pearson bivariate and partial correlations. Sodium was highly correlated with kcal intake ($r=0.90$, $p<0.001$). Both absolute sodium intake and sodium density were positively correlated with systolic BP ($r=0.53$, $p=0.02$ and $r=0.50$, $p=0.02$, respectively). After controlling for kcals, absolute sodium intake was no longer correlated with systolic BP ($r=0.85$, $p=0.18$). After controlling for body mass index, the relation between sodium density and systolic BP became stronger ($r=0.76$, $p=0.02$). Neither absolute sodium intake nor sodium density were correlated with FMD ($r=-0.08$, $p=0.43$ and $r=-0.01$, $p=0.49$, respectively). Our findings suggest energy intake is an important mediator in the relation between sodium intake and CVD risk factors. This analysis can be used as background to perform further studies on this subject.

Introduction

- Excess sodium is one of the major risk factors for cardiovascular disease as it increases blood pressure and can lead to endothelial dysfunction.[1]
- Endothelial cells are important regulators of proper blood movement and functioning in the blood vessels.[2]
- The current recommendation for sodium intake is <2,300mg/day. Unfortunately, most people do not meet these recommendations, and individuals with higher calorie needs may have an especially difficult time meeting these recommendations.[3]
- Sodium density, defined as mg/kilocalorie (caloric intake), may be a better predictor of cardiovascular disease risk than absolute sodium intake.[4]
- Studies examining the link between sodium density and endothelial function are lacking.[5]

Objective

Our objective was to look at the relationship between sodium intake and endothelial function. Furthermore, how the relationship between sodium intake and endothelial function is altered when factoring in how many calories are consumed.

Methods

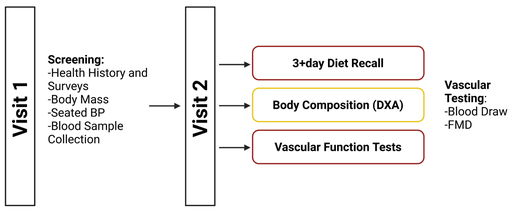


Figure 1: Study Design

Methods

Data collection:

- This study was a secondary analysis of a cross-sectional study in healthy adults with and without obesity aged 20-45 years (n=16).
- Seated blood pressure was taken in triplicate during laboratory visits. The first measure was discarded and the average of the last 2 was reported if they were within 5mmHg.
- Endothelial function was assessed via brachial artery flow-mediated dilation (Figure 2)[6].
- Fasting blood work was taken to conduct a comprehensive metabolic panel and complete blood count.
- Participants collected 3+-day diet records, which were analyzed using Nutrition Data System for Research (NDSR).

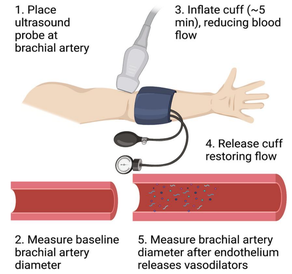


Figure 2: Flow Mediated Dilation Procedure

Statistical analysis:

- Correlation analyses were conducted to see how certain cardiovascular functions are correlated to sodium.
- Partial correlation analysis was done with Kilocalories being what we controlled for. This was done to determine if the relation between the cardiovascular functions and sodium was changed taking calories consumed into account.

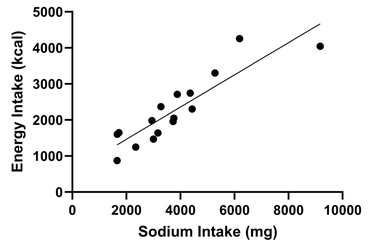
Results

Table 1: Subject Characteristics

Characteristics	
Age, yrs	24 ± 4
Sex (Male/Female, n)	9/7
Sodium, mg	3789 ±1917
Potassium, mg	2599 ±1447
Flow-mediated dilation, %	5.2 ± 4.3
Seated systolic blood pressure, mmHg	112 ± 14
Seated diastolic blood pressure, mmHg	63 ± 8
Energy, kcal	2261.6 ± 955.4
Carbohydrates, g	252.7 ± 114.3
Fat, g	93.8 ± 43.1
Protein, g	102.3 ± 56.2
Height, cm	170.6 ± 9.5
Body mass, kg	78.3 ± 20.1
Body mass index, kg/m^2	26.9 ± 6.3
Total cholesterol, mg/dL	157.4 ± 27.7
Low-density lipoproteins, mg/dL	86.8 ± 27.9
High-density lipoproteins, mg/dL	52.7 ± 8.4
Triglyceride, mg/dL	89.3 ± 27.9
Fasting blood glucose, mg/dL	95.4 ± 5.5
Sodium density, mg/kcal	1.7 ± 0.3

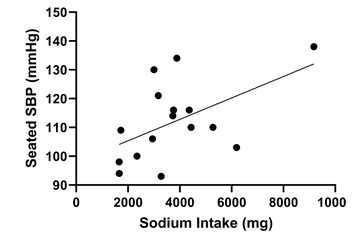
Values are mean ± standard deviation unless otherwise noted.

Results



Pearson Correlation: r=0.90 p<0.001

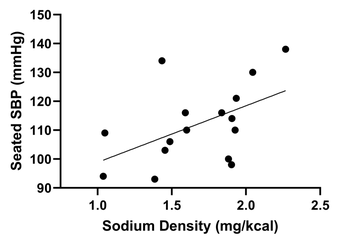
Figure 3: Correlation between sodium intake and energy intake



Pearson Correlation: r=0.53 p=0.02

Controlling for kcal: r=0.85 p=0.18

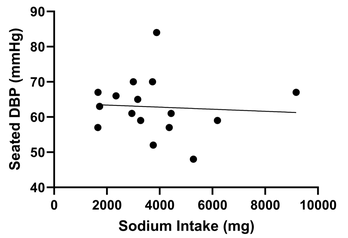
Figure 4: Correlation between sodium intake and seated SBP



Pearson Correlation: r=0.50 p=0.02

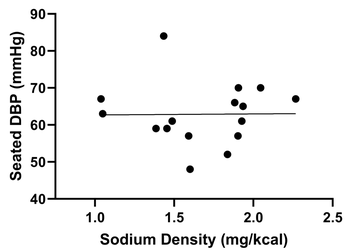
Controlling for BMI: r=0.76 p=0.02

Figure 5: Correlation between sodium density and seated SBP



Pearson Correlation: r=-0.07 p=0.40

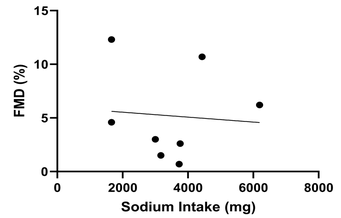
Figure 6: Correlation between sodium intake and seated DBP



Pearson Correlation: r=0.01 p=0.48

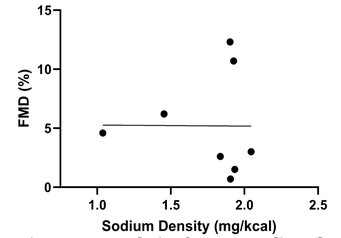
Figure 7: Correlation between sodium density and seated DBP

Results



Pearson Correlation: r=-0.08 p=0.43

Figure 8: Correlation between sodium intake and FMD



Pearson Correlation: r=-0.01 p=0.49

Figure 9: Correlation between sodium density and FMD

Summary and Conclusions

- Sodium is strongly correlated to calorie (energy) intake.
- Sodium and sodium density were not related to FMD.
- Sodium intake was positively correlated with seated systolic blood pressure. When we controlled for energy intake the strength increased but the relationship was no longer significant.
- Sodium density was positively correlated with seated SBP.
- Neither sodium nor sodium density was positively correlated with seated diastolic blood pressure.
- **Our findings suggest energy intake is an important mediator in the relation between sodium intake and CVD risk factors.**
- Further studies should be done to evaluate the relationship between sodium density and cardiovascular health.

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