Relationship of blood pressure to sodium excretion in a population survey


Wellcome Medical Research Institute, Department of Medicine, and Department of Preventive and Social Medicine, University of Otago Medical School, Dunedin, New Zealand

Summary
1. Blood pressure, height, weight and 24 h urinary output of sodium, potassium and creatinine were measured in over 500 adults of each sex during a health survey of the population of a small town.
2. Both systolic and diastolic pressure were significantly related to Quetelet's index (weight/height²) and heart rate.
3. There was no significant relationship between blood pressure and output of sodium or potassium, sodium/potassium ratio or sodium/creatinine ratio.

Key words: blood pressure, population, Quetelet's index, sodium excretion.

Introduction
The relationship between blood pressure and 24 h urinary output of sodium was examined during a survey of the population of Milton, a small New Zealand country town.

Method
The survey was carried out from 7 a.m. to 12 noon daily during one week of May 1975, in the country town of Milton, 54 km south of Dunedin. Just over 1200 people, aged 16 and over, took part, i.e. about 83% of the available population. The procedures and methods have already been described (Simpson, Nye, Bolli, Waal-Manning, Goulding, Phelan, de Hamel, Stewart, Spears, Leek & Stewart, 1978a; Simpson, Waal-Manning, Bolli & Spears, 1978b). Investigations included height (without shoes; to nearest cm) and weight (without shoes, coat or jacket to nearest 0.1 kg), from which Quetelet's index, weight/height², was derived; blood pressure and heart rate (seated; electronic version of the London School of Hygiene and Tropical Medicine blind manometer; phase IV for diastolic; 3 readings of which the 3rd has been used in the present analysis of results); 24 h collection of urine on the previous Sunday; measurement of sodium (Na⁺), potassium (K⁺) and creatinine in the urine samples. The subjects were unaware that there was a particular interest in salt.

The data were subjected to multiple-regression analysis. In addition, the highest and lowest quintiles for various parameters have been compared. Data from persons on antihypertensive therapy, or on diuretics or β-adrenoreceptor-blockers from any cause, were excluded.

Results
Blood pressure, especially systolic, rose with age; it was lower in women than in men in the youngest age groups but was higher in women than in men in the older age groups, in spite of antihypertensive treatment being more common in women (see Simpson et al., 1978b for details).

Mean 24 h Na⁺ excretion (all ages) was 173 ± 75 (sd) mmol for men and 140 ± 53 mmol for women. There was no age-related trend after the age of 20 years; below 20 years, excretion of Na⁺ was lower in both sexes (details given in Simpson et al., 1978a).

Stepwise regression analysis showed that both systolic and diastolic blood pressure were significantly related to age, Quetelet's index and heart
TABLE 1. **Mean values for several variables in the highest and lowest quintiles of systolic blood pressure**

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highest quintile (n = 113)</td>
<td>Lowest quintile (n = 113)</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>155</td>
<td>105</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>96 ***</td>
<td>69</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>77 ***</td>
<td>68</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>81 ***</td>
<td>72</td>
</tr>
<tr>
<td>Quetelet's index</td>
<td>2.72 ***</td>
<td>2.41</td>
</tr>
<tr>
<td>Na⁺ output (mmol/24 h)</td>
<td>175</td>
<td>174</td>
</tr>
<tr>
<td>Age (years)</td>
<td>40</td>
<td>39</td>
</tr>
</tbody>
</table>

Previous studies of the relationship between blood pressure and sodium output within a population have given conflicting results. Whereas Joossens *et al.* (1970) in Belgium, and Morgan, Carney & Wilson (1975) and Doyle, Chua & Duffy (1976) in Australia, have shown a correlation, Miall (1959) and Dawber, Kannel, Kagan, Donabedian, McNamara & Pearson (1967) found none. The Belgian population was, however, not homogeneous, the elderly being drawn from a separate group and having a particularly high sodium/creatinine ratio. Also the correlation between sodium output and blood pressure in women was not significant when age was taken into account (as it must be). The Australian papers compare sodium excretion of 428 mild hypertensive subjects and 53 normotensive subjects from a screening survey and found 24 h sodium excretions of 141 and 118 mmol respectively. However, there were proportionately more female subjects in the normotensive group and women have, on average, a lower excretion of sodium than men. Morgan *et al.* (1975) compare these values with a mean sodium excretion of 185 mmol in 150 hypertensive men referred to their hospital clinic. In the Dunedin Hypertension Clinic, mean 24 h sodium excretion in newly referred patients is about 175 mmol for men and 137 mmol for women, i.e. no higher than the mean for the population of Milton.

Regardless of whether the Belgian and Australian studies have provided the right answers, possible errors in our own results have to be considered. Blood pressure recordings during a busy survey are not ideal and single 24 h collections of urine in a population almost inevitably contain some irregularities in the collections. However, we believe that the vast majority of
subjects did their best to make accurate collections. The use of sodium/potassium ratio and sodium/creatinine ratio should, to some extent, overcome inaccuracies in the collection of urine but these variables fared no better than sodium in the regression analysis.

It is evident that the relationships between blood pressure, age, Quetelet's index and sodium output are complex. However, exclusion of Quetelet's index from the regression analysis does not bring out any correlation between sodium output and blood pressure.

We are forced to conclude that if there is a relationship between sodium intake and blood pressure, it is not a simple one. No doubt the average intake of salt is quite unnecessarily high but the epidemiological evidence on which to base a major public health campaign to reduce salt intake is shaky. Freis (1976) has suggested that the reason why a link between sodium intake and blood pressure is so hard to find is that once the intake is over 60 mmol/day, the excess is immaterial. More studies are clearly needed.

Acknowledgments

This work was supported by the Medical Research Council of New Zealand and the National Heart Foundation of New Zealand. The assistance of the Milton Rotary Club is gratefully acknowledged.

References


