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Tap Water Calcium and its Relationship to Renal Calculi and 24 h Urinary Calcium Output in Great Britain*

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Summary. Tap water calcium content in Great Britain has been re-determined and found to vary with geological age; the older the land mass the lower is the local tap water calcium content. No obvious correlation was observed between local tap water calcium content and the number of patients discharged from hospital with a first diagnosis of renal calculi. Variations in tap water calcium content were found to account for less than three per cent of the variation observed in 24 h urinary calcium output.

Key words: Tap water calcium, Urinary calcium, Renal calculi.

INTRODUCTION

Historically, renal calculi have been associated with hard water and patients with renal calculi advised to live in soft water areas or buy water softeners. This premise has been questioned and it has even been suggested that the incidence of renal stones may be highest in soft water areas (4, 8), whilst the findings of others have been inconclusive (1). It was decided to re-examine this controversy.

Tap Water Calcium Content

We were unable to find in the literature or obtain from the Water Board any comprehensive information with regard to the calcium content of tap water for Great Britain. One thousand and ninety-two tap water samples were therefore obtained personally and the results, when plotted in the form of a histogram, showed three peaks permitting the subdivision of tap water into soft, medium and hard with respective calcium contents of 0 to 0.74, 0.75 to 1.74, and 1.75 to approximately 4.0 mmol/ litre (Fig. 1).

On plotting the results on a geological map the calcium content of tap water could be broadly related to the geological age of the area; tap water with the highest calcium content primarily occurring in land areas formed during the last 190 million years, tap water with the lowest calcium content primarily occurring in land areas formed prior to 225 million years ago (Fig. 2).

Incidence of Renal Calculi

The true incidence of renal calculi in Great Britain is unknown. However it is possible to compare the incidence between soft and hard water areas by comparing the number of patients discharged from hospitals with a first diagnosis of renal calculi (Hospital Activity Analysis, Code No. 592). To reduce bias caused by specialist hospital units the comparison has been done on a Health Region basis and the number of discharges related to the population concerned.

There is no obvious correlation between water hardness and the number of patients discharged from hospital with a first diagnosis of renal calculi in Great Britain, (Table 1), the incidence varying from 16 to 27 per 10^5 population in both soft and hard water regions.

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Table 1. Hospital discharges, in regions with primarily 'soft' or 'hard' tap water, with a first diagnosis of renal calculi per 10^5 population for the year of 1975

Health Authority (H. A.)	Number of discharges	Water hardness
North Western R.	16	Soft
Wales	17	Soft
Northern R.	17	Predominantly Soft
Yorkshire R.	23	Predominantly Soft
Scotland[a]	27	Predominantly Soft
Oxford R.	17	Predominantly Hard
Wessex R.	21	Predominantly Hard
N. W. Thames R.	21	Hard
N. E. Thames R.[b]	24	Hard
East Anglia R.[b]	26	Hard

r. = Region

[a] Statistics for 1974 used

[b] Statistics not comprehensive

Table 3. Scottish hospital discharges with a first diagnosis of renal calculi per 10^5 population related to bed availability for the year of 1974. Scotland is a 'soft' water country

Area health authority	Number of discharges	Bed availability[a]
Orkney	12	4.5
Highland	19	5.1
Argyll and Clyde	21	4.4
Borders	24	4.8
Tayside	24	5.8
Lanark	25	4.7
Lothian	25	5.3
Forth valley	26	4.5
Dumfries and Galloway	27	4.5
Fife	28	4.4
Ayrshire and Arran	30	4.5
Greater Glasgow	31	5.6
Grampian	36	5.8
Shetland	42	4.0
Western Islands	57	4.7

[a] 'Bed availability' is the number of short stay patients (excluding maternity) discharged per year per 10^2 population

Table 2. Comparison of 24 h urinary calcium output related to creatinine in four districts of different water 'hardness'

	Tap water calcium mmol/litre	Urinary calcium related to creatinine units:-mmol/day		Number of samples
		Mean	S.D.	
Plymouth	0.2	0.34	0.16	46
Redhill	1.0	0.36	0.18	54
Worthing	2.4	0.39	0.12	52
Ipswich	3.5	0.39	0.15	42

24 h Urinary Calcium Output

At least 60% of patients with idiopathic renal calculi have hypercalciuria (6). If hard water enhances renal calculi formation, people living in hard water areas should excrete more calcium in their urine than people living in soft water areas. To appraise this hypothesis 24 h urines were collected from laboratory staff in four areas of differing water hardness. The urines were all collected during the winter months so that any seasonal variations alleged by some to occur (7), but denied by others (3), would be minimal. Results have been related to creatinine output to reduce bias due to variations in the proportion of males to females in the different groups (5).

The apparent increase in urinary calcium output with increasing water hardness (Table 2) is too small to permit exact statistical analysis. Variation in tap water calcium content probably accounts for less than three per cent of the variations observed in urinary calcium output. Dauncey and Widdowson (2) compared urinary calcium output of four soft water areas with that of London (moderately hard) and found no significant difference.

DISCUSSION

Disease comparisons based on hospital discharge records can be criticised, but no alternative statistics of similar comprehensiveness exist. The fact that these statistics fail to show any correlation between tap water calcium content and the number of patients discharged from hospital with

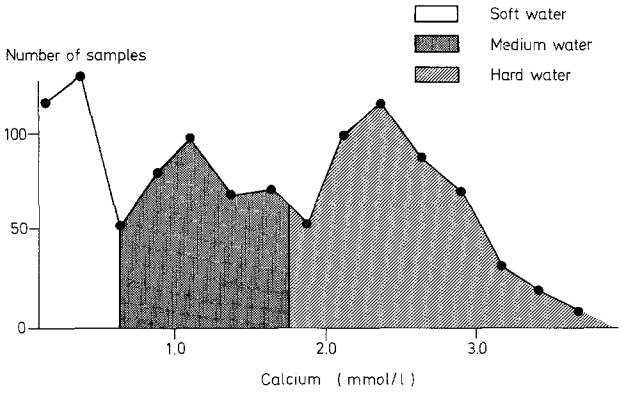

Fig. 1. Histogram of tap water calcium content in Great Britain

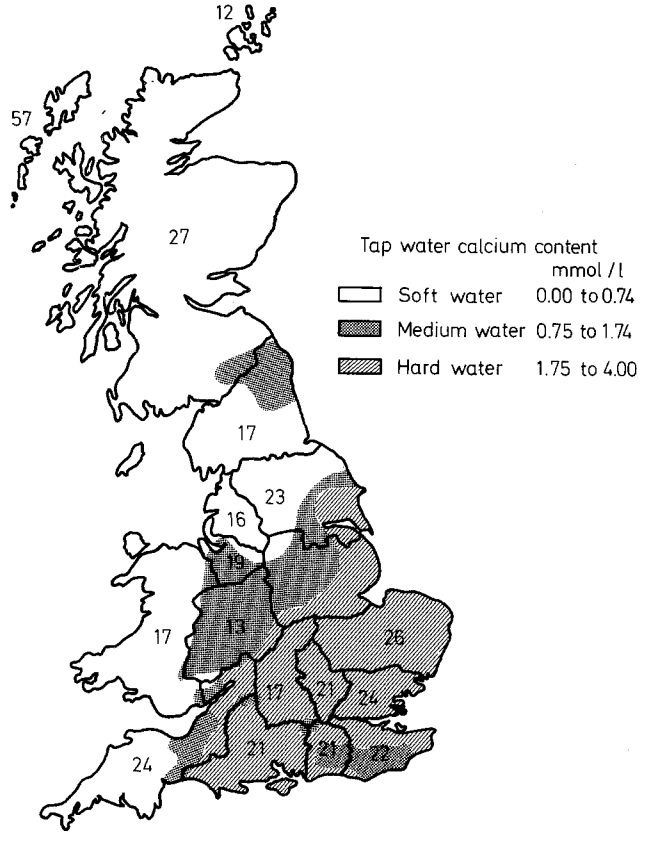

Fig. 2. The figures are the number of patients in each hospital region discharged with a first diagnosis of renal calculi (HAA Code 592) per 10^5 population for the year of 1975. There is no obvious correlation between the figures and tap water hardness

a first diagnosis of renal calculi suggests, but does not prove, that there is no correlation between tap water calcium content and the incidence of renal calculi. Williams (9) is of the opinion that hospital discharge records are primarily related to bed availability and demonstrates this with regard to renal calculi using the figures of Barker and Donnan (1) and Spearman's rank order correlation coefficient. However, the correlation coefficient using conventional regression analysis on the same figures is O. 21 which gives a probability of 0. 08 which is not significant. Detailed analysis of the results for mainland Scotland, which is a soft water country with a relatively uniform bed availability, shows the number of patients discharged from hospital with a first diagnosis of renal calculi to vary from 19 to 36 per 10^5 population (Table 3). Thus with regard to Scotland the variable number of patients discharged from hospital with a first diagnosis of renal calculi would appear to be independent of bed availability and the calcium content of tap water.

Failure to show any marked increase in urinary calcium as the calcium content of tap water increases also suggests that the calcium content of tap water is unlikely to be a factor influencing the incidence of renal calculi.

The older the geology of a region in Great Britain the lower is the tap water calcium content. Sea water calcium content approximates to 10 mmol/litre, three times higher than the amount present in hard water. The very high calcium content of sea water suggests that rain leaches calcium out of the land into the sea.

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