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Seasonal and Geographic Variations in Urinary Composition in England, Scotland and Wales

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Summary. Aliquots of 24 hour urine samples were collected from a series of normal doctors in various areas of England, Scotland and Wales. The total volume was recorded and aliquots sent in for analysis for sodium, potassium, urea, creatinine, calcium, phosphate, urate, magnesium and oxalate. Geographical variations in urinary composition were small except for a raised oxalate content in Scotland. Likewise, seasonal variations were small and not systematic with the notable exception of a summer rise in oxalate content in all areas.

Key words: Urine - Composition - Seasonal - Geographic.

In a previous study in 1975 (10) it was observed that the incidence of renal stones in Great Britain rose with increasing latitude from 2.07 cases per 1,000 hospital admissions in Plymouth on the South Coast to 11.11 cases per 1,000 hospital admissions in Glasgow, Scotland. Why this should be so is hard to understand. It was suggested that a decreased incidence of intake of fruit and vegetables in southern areas might result in lowered urinary magnesium but no evidence was available on urinary composition in the different areas to support such a hypothesis. It was therefore decided to undertake a survey of normal urine composition in certain areas of Great Britain. It was decided to write to individuals in the various areas inviting each one to collect a 24 hour urine sample measure the volume and send in an aliquot. Such an approach pre-supposes that the individual selected would understand how to collect a 24 hour urine sample and measure the volume and it was therefore decided to write to doctors only, inviting their co-operation.

Since this study was to be spread over several years it was thought that a second problem could be studied simultaneously. A cross sectional study of monthly variations in urinary calcium in Leeds (8) reported a striking rise in the summer months. A longitudinal study in London (2) failed to confirm this finding and showed no change between summer and winter. Recently a longitudinal study from Leeds (7) showed a rise in urinary calcium

Table 1. 24 hour urine volume in ml according to area and time of year. Male subjects only

	N	Mean	% S.D.
London	83	1670	36.7
Wales, Devon and Cornwall	76	1695	31.5
Northern counties	81	1666	32.4
Scotland	70	1711	33.6
% Swing: 2.63			
Jan/Feb	50*	1718	35.8
Mar/Apr	83	1742	31.1
May/June	54	1663	40.8
July/Aug	56	1743	38.4
Sept/Oct	29	1626	34.9
Nov/Dec	39	1780	39.4
% Swing: 6.57			

None of these differences are statistically significant

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Table 2. Urea excretion (mMol/24hr) according to area and time of year. Male subjects only

	N	Mean	% S. D.
London	78	333.2	26.0
Wales, Devon and Cornwall	70	357.6	25.4
Northern counties	78	361.5	27.8
Scotland	71	346.9	28.1
% Swing: 1.09			
Jan/Feb	49	354.4	31.4
Mar/Apr	80	359.9	28.3
May/June	51	362.8	23.6
July/Aug	53	349.3	32.4
Sept/Oct	29	331.2	31.4
Nov/Dec	40	337.4	27.1
% Swing: 8.78			

None of these differences are statistically significant

Table 3. Creatinine excretion (mMol/24hr) according to are and time of year. Male subjects only

	N	Mean	% S. D.
London	77	*13.54	22.3
Wales, Devon and Cornwall	74	14.04	24.1
Northern counties	78	*14.73	21.2
Scotland	70	13.82	22.5
% Swing: 8.08			
Jan/Feb	48	13.70	22.6
Mar/Apr	83	14.23	27.4
May/June	53	14.14	21.7
July/Aug	53	13.83	33.0
Sept/Oct	29	13.42	21.8
Nov/Dec	39	13.41	24.0
% Swing: 5.69			

*P = 0.10

Seasonal differences not statistically significant

in the summer but this was rather less than in the first paper from Leeds. The data received in the present study was therefore examined to see if urine composition varied seasonally in the various areas of Great Britain.

MATERIALS AND METHODS

From January 1975 until the end of the survey in October, 1977 2,800 packets were sent by post to medical practitioners in four selected areas of Great Britain. The four areas were 1) Greater London , 2) Wales, Devon and Cornwall, 3) Northern Counties (old counties of Yorkshire, Lancashire, Northumberland, Durham, Westmoreland, Cumberland), 4) Scotland. The packet contained an invitation to contribute to the survey an aliquot of a 24-hour collection of their own or a member of their family's urine, a plastic universal container in which to put it, instructions and an identification slip for recording the volunteer's name, age, sex, 24 hour volume and other special information. In order to minimise sampling errors, equal numbers were sent to doctors in each of the four areas at approximately the same season of the year.

The choice of recipient was made easier by reference to the section of the Medical Register in which practitioners are listed by geographical location. For instance, the first batch of containers were sent to addresses in Acton, Aberystwith, Accrington and Aberdeen. In Wales, Devon and Cornwall parcels were posted to every fifth consecutive entry, in all other regions to every tenth name on the list.

Initially the containers for receiving the aliquots were sent out without preservative, but it was found that a few aliquots became sufficiently contaminated to interfere with oxalate or magnesium determination and during the latter half of the survey, the universal containers were dispatched with a small crystal of thymol added.

Of the large number of doctors invited to take part in the scheme, a total of 342 aliquots were returned. Of these four had to be discarded, either because of insufficient data or because, in view of information given, abnormal urine chemistry might have been expected in these cases. Also included in the survey was a batch of 15 aliquots supplied by students at St. Thomas's Hospital Medical School, a by-product of a physiology project conducted there.

On examining the results it was found that 319 were from males and 34 from females. When broken down geographically and seasonally the numbers in the female group were rather too low for statistical purposes and these have therefore been omitted from the report.

On receipt in the laboratory the survey samples were included in routine batch mode analysis for

Table 4. Sodium excretion (mMol/24hr). According to area and time of year. Male subjects only

	N	Mean	% S. D.
London	82	*167.1	35.7
Wales, Devon and Cornwall	74	183.4	39.2
Northern counties	81	188.4	35.1
Scotland	70	*192.8	33.9
% Swing: 13.30			
Trend: Rising from south to north			
Jan/Feb	50	184.2	38.7
Mar/Apr	85	191.7	37.6
May/June	54	183.6	34.8
July/Aug	54	173.2	34.4
Sept/Oct	29	179.6	37.6
Nov/Dec	40	180.1	41.8
% Swing: 9.65			
Trend: Falling in summer			

*P = 0.01. Seasonal differences not statistically significant

Table 5. Potassium excretion (mMol/24 hr) according to area and time of year. Male subjects only

	N	Mean	% S. D.
London	83	73.1	29.6
Wales, Devon and Cornwall	73	72.8	27.1
Northern counties	80	73.4	27.8
Scotland	70	74.9	30.2
% Swing: 2.80			
Jan/Feb	49	70.4	27.3
Mar/Apr	83	75.3	27.4
May/June	52	71.3	29.3
July/Aug	56	76.7	33.1
Sept/Oct	29	69.3	28.4
Nov/Dec	39	71.7	32.4
% Swing: 9.65			

None of these differences are statistically significant

nine parameters: urea, creatinine, sodium, potassium, calcium, inorganic phosphorus, urate, magnesium and oxalate.

The methods in use for routine analysis in this laboratory during the period of the survey were as follows:

Urea, creatinine, inorganic phosphorus and urate by standard Technicon AA II methodologies, described on AA II method sheets, 1, 11, 04, and 13 respectively; sodium and potassium by emission flame photometry using lithium as an internal standard; calcium by emission flame photometry after pre-treatment with perchloric acid for the first 50 samples and flame atomic absorption technique (12) for the remainder; magnesium by the atomic absorption method (5); oxalate by the enzymatic technique (3).

RESULTS

The results for the various parameters are presented for males only in Tables 1-10. In each case in addition to mean and standard deviation, a figure has been given to indicate the percentage change from the highest to the lowest figure, i.e. the "swing". Each table also shows whether the highest figure is statistically different from the lowest. A number of small problems were encountered during the analyses and the statistical treatment of the results. The first of these has already been mentioned, the loss of some early magnesium and oxalate values due to bacterial contamination. Another problem was that in a few cases the measurement of total volume was suspect. It was therefore found necessary to exclude outriders, i.e. all values more than three standard deviations from the mean.

DISCUSSION

It has previously been reported (4) that seasonal changes in urinary composition in the London area are negligible apart from a rise in oxalate and fall in volume during the summer months. However, results from Leeds (7, 8) suggested there could be seasonal variations in other parts of the country that were not to be seen in London. The present study however shows that seasonal variation in urin-

Table 6. Calcium excretion (mMol/24hr) according to area and time of year. Male subjects only

	N	Mean	% S. D.
London	81	4.91	44.6
Wales, Devon and Cornwall	72	5.09	38.3
Nothern counties	82	4.73	44.0
Scotland	71	4.73	43.8
% Swing: 7.07			
Jan/Feb	48	4.49	47.7
Mar/Apr	81	5.21	44.9
May/June	52	4.59	40.5
July/Aug	51	5.16	41.9
Sept/Oct	28	4.89	44.2
Nov/Dec	41	4.83	41.6
% Swing: 13.82			

None of these differences are statistically significant

Table 7. Inorganic phosphate excretion (mMol/24hr) according to are and time of year. Male subjects only

	N	Mean	% S. D.
London	80	*29.6	30.4
Wales, Devon and Cornwall	72	*33.6	27.7
Northern counties	78	32.8	29.3
Scotland	71	31.9	26.3
% Swing: 11.90			
Jan/Feb	48	**28.7	30.0
Mar/Apr	83	**34.8	26.1
May/June	54	31.8	27.7
July/Aug	55	33.7	33.2
Sept/Oct	30	31.1	37.3
Nov/Dec	40	30.1	35.5
% Swing: 18.10			

*$\underline{P}$ = 0.01 **$\underline{P}$ = 0.001

Table 8. Uric acid excretion (mMol/24hr) according to area and time of year. Male subjects only

	N	Mean	% S. D.
London	84	*4.13	29.8
Wales, Devon and Cornwall	75	*4.80	27.9
Northern counties	80	4.45	28.8
Scotland	72	4.21	31.4
% Swing: 13.96			
Jan/Feb	72	**4.14	32.4
Mar/Apr	49	4.57	29.1
May/June	82	**4.62	26.0
July/Aug	54	4.36	34.2
Sept/Oct	30	4.31	31.3
Nov/Dec	40	4.25	26.6
% Swing: 10.39			

*$\underline{P}$ = 0.001 **$\underline{P}$ = 0.05

Table 9. Magnesium excretion (mMol/24hr) according to area and time of year. Male subjects only

	N	Mean	% S. D.
London	79	4.87	31.4
Wales, Devon and Cornwall	75	5.07	31.6
Northern counties	80	4.86	36.8
Scotland	68	5.08	33.9
% Swing: 4.33			
Jan/Feb	46	4.92	36.6
Mar/Apr	83	4.85	32.2
May/June	54	4.87	34.3
July/Aug	53	5.19	31.4
Sept/Oct	28	5.03	35.0
Nov/Dec	39	4.84	36.4
% Swing: 6.55			

None of these differences are statistically significant ary composition over the whole country (Tables 1-10) are similar to those reported for London (4). Furthermore when seasonal variations are compared on a regional basis, no new trends can be discerned even in the Northern counties area that are not shown in those for the whole country. For the sake of simplicity therefore only seasonal variations for the whole country are reproduced here.

The greatest percentage difference observed were in oxalate excretion with a rise of 27% of the winter value in the summer and this is in agreement with previous reports (2, 4). It is also of interest that the region showing the highest urinary oxalate value is Scotland, the region previously noted to have the highest incidence of renal calculi. Although it is tempting to link these two facts as cause and effect, it must be noted that the correlation does not extend to other areas since the Northern counties of England showed the lowest urinary oxalate.

Urinary calcium did not vary greatly from area to area and no definite seasonal trend can be observed, so agreeing with previous results from the London area (2) and contrasting with those obtained from Leeds (7, 8). Even in Northern county regions no seasonal variations in urinary calcium could be discerned and why these results differ from the Leeds results remains a mystery.

Certain other variations in urinary composition, although small, can be readily interpreted and understood. Firstly, urinary volume was slightly higher in Scotland and showed an overall slight fall in the summer months and this can presumably be attributed to the higher environmental temperature in the south and in the summer causing increased sweat loss and therefore reduced urinary volume. Secondly, and in line with this, the urinary sodium dropped slightly in the summer and showed a steady but small rise with increasing latitude. Other variations in urinary composition were irregular and not easy to understand but mostly rather small.

There is no general agreement at this time on just how the incidence of renal calculi does vary over this country. While a survey from this laboratory (10) showed a rise in incidence with latitude others (1) have disagreed and even suggested the reverse as true. The latter paper however unfortunately excluded Scotland which may have the highest incidence of renal calculi (10). If there are geographical differences in the incidence of renal calculi than it might be expected that there would be corresponding differences in urine composition since all agree that the majority of renal calculi in this country are "metabolic" rather than "infected" (6, 9) and this is especially true of males who are really the subject of this study. The results reported here show no marked variation in urinary composition from region to region of this country. The only possible exception is oxalate, but more

Table 10. Oxalate excretion (mMol/24hr) according to area and time of year. Male subjects only

	N	Mean	% S. D.
London	79	0. 28	42. 9
Wales, Devon and Cornwall	76	0. 28	35. 7
Northern Counties	80	*0. 26	42. 3
Scotland	74	*0. 30	40. 0
% Swing: 13. 30			
Jan/Feb	48	**0. 24	50. 0
Mar/Apr	78	0. 27	40. 7
May/June	49	0. 27	40. 7
July/Aug	54	**0. 33	36. 4
Sept/Oct	29	0. 29	44. 8
Nov/Dec	40	0. 26	38. 5
% Swing: 27. 27			

*_P_ = 0. 05 **_P_ = 0. 001

work would be required to confirm that the higher excretion level observed for Scotland is really significant. Setting oxalate aside therefore, possible reasons for a lack of variation in urine composition should be considered. Firstly, the sample used, namely doctors and their near relatives might not be typical of the general population. However it has been shown (11) that the high incidence of renal calculi in Scotland applies particularly to Scottish doctors and therefore one might expect this survey to accentuate any changes in urine composition rather than reduce them. Secondly there might be other factors in urine which are relevant and which have not been measured. In this context citrate and pyro-phosphate and other inhibitors of crystal formation and growth must be considered. Unfortunately these were not measured and it remains a possibility that these vary geographically. Finally there remains a possibility that a comparison of "means" alone may be misleading by concealing extreme variations in some groups that are much bigger than in others. However, comparison of the standard deviations in Tables 1-10 shows that they do not differ significantly either geographically or seasonally.

It is therefore concluded that with the possible exception of oxalate, no changes in urine composition can account for geographical variation in incidence of urinary calculi.

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