Arakawa's* Reaction of Lactating Mothers and Calcium Content of their Urine (Preliminary Report).

93rd Report of the Peroxidase Reaction.

By

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Literature¹⁾²⁾³⁾ shows that calcium deficit in the diet will cause a negative calcium balance. Even if calcium intake is of normal value, a negative balance will occur, as literature shows, if the calcium requirement of the body is increased, as for instance, in the case of pregnancy or lactation.⁴⁾⁵⁾⁶⁾⁷⁾⁸⁾ In such a case the amount of calcium required by the body is very large on account of the fetus or suckling, so that the pregnant or lactating are apt to suffer from different diseases⁴⁾⁹⁾ rising from calcium carence.

* Arakawa-positive may be used in two different senses. One of these is: Arakawa-positive in biochemical sense. A sample of human milk is said to have become Arakawa-positive, when it became blue on the addition of Arakawa's reagent. There it means that the sample is not negative to Arakawa's reaction. Arakawa-positive in clinical sense: A sample of human milk is clinically Arakawa-positive only when it shows such a reaction as ++ or +++ in one minute of the addition of Arakawa's reagent. Another sample of human milk may be Arakawa-positive in the first described sense, but yet clinically negative.

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Infants nursed by mothers of calcium deficit are said to be predisposed to dental caries or ricket.⁴⁾⁽¹¹⁾ And milk secreted by such a mother is according to Toverud⁴⁾ and Courtney¹⁰⁾ poorer in calcium. Though the urine is not the main excrete for elimination of calcium, individuals⁷⁾⁽²⁾⁽⁴⁾ or lactating mothers⁴⁾⁽⁷⁾ with calcium low in diet show, as literature reveals, a low value of the salt in the urine.

According to Uga¹²⁾ of our Department, it seems that the intensity of Arakawa's reaction and the calcium content in human milk show a close relation between themselves. Now I investigated the relation between the intensity of Arakawa's reaction of lactating mothers and the calcium content in their urine.

Method of Experiment.

1. Materials. Lactating mothers of sick infants who visited our Dispensary. Of course it was impossible to collect whole day urine; the urine voided during the time between 9 and 11 A. M. was used for the purpose.

2. Testing of Arakawa's reaction.¹³⁾ Milk from each mother was examined with Arakawa's reagent within three hours of obtaining and the reaction itself was followed as late as 5 minutes.

3. Method of analysis.¹⁴⁾ As it was my object to know, not the precise calcium content in urine, but the difference of calcium content between Arakawa-positive and Arakawa-negative mothers, the method used was a simple and rapid one. Calcium in 2 c.c. of the urine is precipitated as calcium-oxalate by the addition of ammonium oxalate. The precipitate is dissolved in sulphuric acid and titrated with N/100 KMnO_4 .

Results of Experiment.

Control cases :—

17 healthy female adults, not lactating, of the age between 20 and 30 years were used for controls. The urine voided during the time between 9 and 11 A. M. was used. The result is shown in Table 1 (Cf. Table 1).

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TABLE 1.
Calcium content in urine of normal female adults.

Ca mgrms. %	Number of cases	
6.4—10.0	3	(17.7%)
—15.0	7	(41.3%)
—20.0	4	(23.5%)
—25.0	2	(11.7%)
—29.4	1	(5.5%)
Average	15.4 mgrms. %	

As will be seen from the table, calcium content in these urines was 15.4 mgrms. %, about of the value shown by Cushny.¹⁵⁾ There were 3 cases with the content below 10 mgrms. %, but none with the content below 5 mgrms. %.

Cases of lactating mothers with different Arakawa's reaction :—
150 lactating mothers were examined. The results are presented in Table 2, 3, 4 and 5.

TABLE 2.
Calcium content of urine of Arakawa-positive mothers.

Case No.	Age* m=months y=years	Arakawa's reaction								Ca of urine mgrms. %
		Right				Left				
		0'	1'	3'	5'	0'	1'	3'	5'	
1	1 y 1 m	±	++	+++	+++	±	++	+++	+++	7.8
2	11 m	±	++	+++	+++	±	++	+++	+++	6.24
3	11 m	—	++	+++	+++	—	++	+++	+++	5.9
4	5 m	±	++	+++	+++	±	++	+++	+++	13.2
5	5 m	+	+++	+++	+++	+	+++	+++	+++	32.6
6	7 m	±	++	+++	+++	—	++	+++	+++	13.2
7	5 m	±	++	+++	+++	—	++	+++	+++	1.8
8	9 m	±	++	+++	+++	±	++	+++	+++	8.6
9	10 m	±	++	+++	+++	±	++	+++	+++	4.9
10	1 y	±	++	+++	+++	±	++	+++	+++	11.5
11	6 m	±	++	+++	+++	±	++	+++	+++	5.8
12	4 m	—	++	+++	+++	—	++	+++	+++	12.9
13	8 m	±	++	+++	+++	±	++	+++	+++	5.8
14	7 m	—	++	+++	+++	—	++	+++	+++	8.7
15	1 y 1 m	±	++	+++	+++	±	++	+++	+++	5.0
16	6 m	±	++	+++	+++	±	++	+++	+++	4.7
17	6 m	±	++	+	+	±	++	+	+	17.8
18	1 y 1 m	±	++	+++	+++	±	++	+++	+++	5.6
19	1 y 8 m	—	++	+++	+++	—	++	+++	+++	6.2
20	6 m	++	+++	+++	+++	±	+++	+++	+++	1.4

* Age of infant to show the length of lactation.

15) A.R. Cushny, The secretion of the urine, London, 1917, 15.

TABLE 3.
Calcium content of urine of Arakawa-negative mothers.

Case No.	Age* m=months y=years	Arakawa's reaction								Ca. of urine mgrms. %
		Right				Left				
		0'	1'	3'	5'	0'	1'	3'	5'	
1	10 m	—	—	—	—	—	—	—	—	3.7
2	1 m	—	—	—	—	—	—	—	—	3.3
3	11 m	—	—	—	±	—	—	—	±	7.1
4	1 y 7 m	—	—	—	—	—	—	—	—	9.8
5	4 m	—	—	—	±	—	—	—	±	7.5
6	1 y 9 m	—	—	—	±	—	—	—	±	1.0
7	3 m	—	—	—	—	—	—	—	—	10.4
8	1 m	—	—	—	—	—	—	—	±	4.5
9	1 y 1 m	—	—	—	±	—	—	—	±	9.4
10	4 m	—	—	—	—	—	—	—	—	3.5
11	1 m	—	—	—	—	—	—	—	—	3.1
12	10 m	—	—	—	±	—	—	—	—	7.4
13	2 m	—	—	—	—	—	—	—	—	6.3
14	11 m	—	—	—	—	—	—	—	±	6.6
15	2 m	—	—	—	—	—	—	—	—	10.3
16	2 m	—	—	—	±	—	—	—	±	2.4

* Cf. Foot-note to Table 2.

TABLE 4.
Calcium content of intermediate Arakawa-positive mothers.

Case No.	Age* m=months y=years	Arakawa's reaction								Ca of urine mgrms. %
		Right				Left				
		0'	1'	3'	5'	0'	1'	3'	5'	
1	1 y 10 m	—	+	++	++	—	+	++	++	12.0
2	1 y 5 m	—	—	—	—	—	±	++	++	9.5
3	3 m	—	—	—	—	—	—	±	±	2.5
4	9 m	—	±	±	+	—	±	±	+	17.84
5	10 m	—	—	±	+	—	—	±	+	20.5
6	1 m	—	—	+	##	—	—	++	##	1.15
7	7 m	—	—	—	—	—	+	+	++	3.35
8	1 y 2 m	—	+	##	##	—	±	++	++	16.4
9	11 m	—	±	++	##	±	++	##	##	5.35
10	6 m	—	++	##	##	—	±	++	##	16.4
11	1 y 3 m	—	—	—	±	—	±	±	±	22.7
12	2 y 1 m	—	—	—	—	—	±	±	+	4.6
13	2 y 4 m	—	—	±	+	—	±	±	+	7.9
14	6 m	±	++	##	##	—	—	—	±	29.0
15	1 y 8 m	±	+	+	##	±	+	+	##	25.3
16	3 m	—	±	++	##	—	±	++	++	26.6
17	1 y 2 m	—	+	++	##	—	+	++	##	3.3
18	1 y 1 m	±	+	++	##	±	+	##	##	2.8
19	1 y	—	—	±	±	—	±	++	++	2.8
20	6 m	—	—	+	++	—	±	++	##	21.5

* Cf. Foot-note to Table 2.

Case No.	Age m=months y=years	Arakawa's reaction								Ca of urine mgrms. %
		Right				Left				
		0'	1'	3'	5'	0'	1'	3'	5'	
21	11 m	—	—	—	—	—	—	±	+	9.4
22	7 m	—	±	++	##	—	±	++	##	8.5
23	1 y 5 m	—	±	+	++	—	±	++	##	9.8
24	2 m	—	—	±	±	—	—	±	±	4.2
25	1 y 2 m	—	+	##	##	—	++	##	##	4.9
26	10 m	±	+	++	##	±	+	++	##	11.5
27	3 m	—	±	##	##	—	—	—	—	14.3
28	1 y 5 m	—	—	±	±	—	—	—	—	8.7
29	1 y 1 m	—	±	+	++	—	±	++	##	5.1
30	2 y 5 m	±	+	+	+	—	—	±	+	2.8
31	5 m	—	—	—	—	—	+	+	++	22.7
32	10 m	—	±	+	++					4.4
33	5 m	—	+	##	##	±	++	##	##	12.9
34	10 m	—	±	++	##	—	±	++	##	8.2
35	1 y 9 m	—	—	±	+	—	++	##	##	18.9
36	1 y 5 m	—	±	++	##	—	±	+	+	8.1
37	2 m	—	±	++	##	—	—	+	+	13.6
38	2 m	—	±	+	++	—	±	+	+	5.7
39	4 m	—	+	++	##	—	±	+	++	2.4
40	1 y 6 m	—	±	+	++	—	±	+	++	7.0
41	3 m	±	++	##	##	—	±	+	+	4.1
42	3 m	—	±	++	##	—	—	+	+	6.6
43	5 m	—	+	++	##	—	+	++	##	10.2
44	1 y 1 m	—	—	—	±	—	±	±	+	13.2
45	6 m	—	+	++	##					12.9
46	1 y 5 m	—	+	++	##					5.1
47	9 m	—	±	++	##	—	—	+	##	7.3
48	1 y 3 m	—	±	++	##	—	—	+	##	6.0
49	7 m	±	+	+	++	±	+	+	++	11.8
50	9 m	—	+	++	##	—	—	±	+	3.4
51	10 m	—	±	++	##	—	±	++	##	11.8
52	1 y 5 m	—	—	+	++	—	±	+	##	15.0
53	1 y 7 m	—	+	++	##	—	±	+	+	5.3
54	1 y 11 m	—	±	+	+	—	±	+	+	5.3
55	8 m	—	—	+	+	—	±	##	##	13.4
56	11 m	—	—	+	++	—	±	++	++	1.9
57	7 m	—	±	++	##	—	+	##	##	7.4
58	1 m	—	±	+	++	—	—	+	++	6.0
59	6 m	—	—	—	—	—	—	±	±	3.2
60	1 m	—	+	++	++	±	+	++	++	8.5
61	11 m	—	—	±	++	—	—	±	+	9.0
62	2 m	—	±	±	+	—	+	++	++	4.0
63	2 m	—	+	++	++	—	+	++	++	10.8
64	5 m	±	+	++	++	—	±	+	++	6.6
65	2 m	—	—	—	+	—	+	++	++	5.0
66	8 m	—	—	—	—	—	+	++	++	16.3
67	2 m	—	—	—	—	—	—	±	+	3.5
68	10 m	—	+	##	##	±	++	##	##	7.6
69	4 m	—	+	##	##	—	+	##	##	2.7
70	1 y 7 m	—	+	+	##	±	++	++	##	6.9
71	4 m	±	+	+	++	±	+	+	++	7.0
72	11 m	—	±	+	++	±	++	##	##	3.1
73	10 m	—	—	+	++	—	±	++	++	4.8
74	11 m	—	—	+	+	—	—	+	+	6.4

Case No.	Age m=months y=years	Arakawa's reaction								Ca of urine mgrms. %
		Right				Left				
		0'	1'	3'	5'	0'	1'	3'	5'	
75	2 m	—	±	+	+	—	±	+	+	3.1
76	9 m	—	±	+	±	—	—	±	+	3.3
77	8 m	—	±	+	±	—	±	±	±	6.8
78	1 y 1 m	—	—	+	+	—	—	+	+	5.2
79	10 m	—	+	±	±	—	+	±	±	4.7
80	1 y 11 m	—	±	±	±	—	—	+	+	9.1
81	1 y	—	±	±	±	—	±	±	±	14.0
82	10 m	—	—	—	+	—	—	—	+	10.9
83	1 m	—	±	+	+	—	—	+	+	9.7
84	6 m	—	+	±	±					12.3
85	6 m	—	+	±	±	—	—	+	+	11.8
86	2 m	—	±	±	+	—	±	±	+	11.6
87	9 m	—	+	±	±	—	+	±	±	2.9
88	1 y 11 m	—	±	+	+	—	—	±	±	20.0
89	4 m	—	±	+	+	—	+	±	±	7.5
90	5 m	—	—	±	+	—	—	—	±	10.7
91	1 y 2 m	±	+	±	±	—	—	±	+	22.3
92	6 m	±	+	±	±	±	+	±	±	12.8
93	1 y 8 m	—	±	+	+	—	±	+	+	5.7
94	1 y 5 m	±	+	±	±	±	+	±	±	7.5
95	1 y	±	+	±	±	±	+	±	±	13.0
96	1 m	—	±	+	±	—	—	±	±	8.4
97	1 m	—	+	±	±	—	+	±	±	3.4
98	3 m	—	—	+	±	—	—	—	—	10.8
99	2 m	—	—	—	+	—	—	—	+	16.8
100	1 y 1 m	+	±	±	±	+	±	±	±	7.6
101	4 m	—	±	+	+	—	±	+	+	4.9
102	11 m	±	+	±	±	±	+	±	±	3.0
103	1 y 6 m	—	±	±	±	+	±	±	±	3.4
104	10 m	—	—	±	+	—	—	—	—	7.7
105	5 m	—	±	±	±	—	±	+	±	11.3
106	1 y 4 m	—	—	±	+	—	—	±	+	2.4
107	5 m	—	±	+	±	—	±	+	±	4.0
108	4 m	—	—	—	—	—	±	+	±	12.4
109	8 m	—	—	±	+	—	—	±	+	6.0
110	1 y 1 m	—	±	+	±	—	—	—	—	14.7
111	9 m	—	±	+	±	—	—	—	±	21.6
112	1 m	—	—	—	±	—	+	±	±	4.8
113	1 y 2 m	—	—	—	±	—	—	±	+	4.2
114	9 m	—	—	±	±	—	—	—	±	15.5

TABLE 5.

Relation between Arakawa's reaction and calcium content of urine.

Ca. mgrms. %	Number of cases			Total
	Positive Arakawa's reaction	Intermediate Arakawa's reaction	Completely negative Arakawa's reaction	
1— 5	5 (25%)	34 (29.8%)	7 (43.7%)	46 (31%)
—10	9	38	7	54 } (66.6%)
—15	4	26	2	32
—20	1	7		8
—25	0	6		6
—30	0	3		3
—35	1	0		1
Average	9.1 mgrms. %	9.2 mgrms. %	6.0 mgrms. %	8.8 mgrms. %

In this preliminary report the cases of Arakawa-positive[‡] and completely^{‡‡} negative mothers are yet small in numbers, but the following relation will be seen. Table 5 makes clear that the average calcium content of the urine did not show a striking difference between mothers with positive and with intermediate* Arakawa's reaction, while the calcium content was averagingly of low value in the cases of mothers with completely negative Arakawa's reaction. This fact will again be seen from a comparison of the number of cases with calcium content below 5 mgrms. %. The percentage of such cases was 25% among mothers with positive reaction, 29.8% among mothers with intermediate reaction and 43.7% among mothers with negative reaction.

Now, if Arakawa's reaction is discarded and only the result of calcium determination in all the 150 lactating mothers is considered, then the calcium content in urine is in 46 of all my cases (31%) below 5 mgrms. % and in 100 cases (66.6%) of all below 10 mgrms. %. The average in all cases is 8.8 mgrms. % (Cf. Table 5).

Comment.

As stated above, it is of course impossible to discuss the calcium

[‡] Arakawa's reaction of the intensity (‡ or ‡) on both breasts in one minute.

^{‡‡} Arakawa's reaction of the intensity (— or ±) on both breast even after a lapse of 5 minutes.

* Arakawa's reaction of the intensity between (‡ or ‡) in one minute and (— or ±) in 5 minutes.

amount excreted during one whole day, but if a female adult is assumed to excrete 1200 c.c.¹⁶⁾¹⁷⁾ of the urine in one day's time, then the total calcium amount pro die in urine of lactating mothers in my own investigation will be 0.105 grms. on an average, and in 33% of all these cases, below 0.06 grms. pro die. Compared with such figures reported in literature as 0.24–0.43 grms., 0.14–0.28 grms.¹⁸⁾ 0.1–0.3 grms.¹⁹⁾ 15 mgrms.¹⁵⁾ %, 0.23 grms.¹⁶⁾ in the normal adult and as 0.102–0.309 grms. in the normal female adult²⁰⁾, and also with those of my own control cases, calcium amount in urine shows a distinctly lower value of the lactating mothers in my investigation, especially in completely Arakawa-negative cases.

Conclusions.

This preliminary report will lead to the following conclusions :—

1. Calcium content of the urine is lower in lactating mothers than in healthy female adults.
2. Calcium content of the urine is much lower in lactating mothers with negative Arakawa's reaction than those with positive Arakawa's reaction.

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