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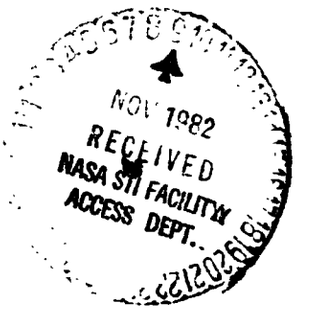

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VOLUNTARY SODIUM INTAKE DURING EFFORT IN HOT ENVIRONMENTS

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In contrast to widely accepted thoughts in the past, about the existence of a threshold for salt in the sense of taste [10], it is held today [2] that there is no feeling for the lack of salt in the human organism that would urge a person on to a voluntary intake of salt, when there is a lack of it in the body. For that reason there have been those who recommended [4,8] addition of salt under conditions of increased perspiration, which is connected with the loss of relatively large quantities of sodium chloride, to prevent interference with the proper salt balance of the human body. It has since been proven [1,5,6 and others], that there is no need for the addition of salt beyond what is contained in a normal diet, ever for people performing strenous work in a warm environment.

The purpose of this study is to investigate which part of the general requirement for sodium chloride in the daily diet stems from a regular voluntary input of salt addition and what are the factors that influence the amount of salt that a person adds to the food at mealtime.

Materials and Methods

Ten marchers (numbers 1 - 10), which participated in a march from Elat to Metullah and on whom careful measurements of salt intake and outflow were performed [1], were equipped with individual salt shakers that were weighed before and after each meal to an accuracy of $\pm$ 0.02 grams.

The medical team (accompanying the marchers) refrained from expressing any opinions in front of the marchers on the importance, or lack of it, of salt consumption. In the course of the test marchers Nos. 6 - 10 were urged to add salt

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during the days 8.3.59 - 9.10.59 (and in general) without being given an explanation of the reason for it.

During the days 8.3.59 - 8.6.59 and 15.8.59 - 18.8.59 (and in general) the men received a diet that contained a large quantity of canned food. On the other days the diet was similar in all respects to that customary among the population of the country .

The laboratory methods and meteorological methods have been explained somewhere else [1,9]. The calculations were made for sodium ,which comprises 40 % ,by weight, of ordinary table salt.

Results

On the average,each man added 0.31 grams of sodium daily to his food (which comes to 0.8 grams table salt). The range of individual differences is broad : Marcher No.1 added salt only to two out of 72 meals that he consumed ,while marcher No.8 added salt to 43 meals and his average voluntary sodium intake was 24 times larger than that of No.1 (see Table 1, No.1).

In the course of 240 "meal days " (a "meal day" includes 3 meals for one man) during the trip there were 140 "days",during which the men ate a regular diet customary for the majority of Israel's population and where the voluntary salt intake was not influenced by outside factors. During 55 of these days the men did not add any salt at all to their food to increase its taste. During 63 "meal days " the voluntary sodium addition to the food came upt to 10 % of the daily sodium requirement and only for 22 " meal days " was the voluntary addition greater than 10 % above the general sodium requirement (see Table No.2) .The general average of voluntary sodium requirement for each "meal day " during the trip was 4.7 % of the general sodium requirement.

Table 1

Voluntary Daily Sodium Addition to Food, in Grams

Date	Subject 1	2	3	4	5	6	7	8	9	10	Daily Voluntary Average	Daily Average Sodium Intake (in Grams)
3	-	0.04	0.24	0.04	-	0.16	1.52	0.20	-	0.04	0.22	5.63
4	-	0.12	1.20	-	-	0.68	1.92	0.56	0.88	0.80	0.62	6.49
5	-	0.24	0.16	-	-	0.84	1.56	0.88	0.32	0.28	0.43	7.44
6	-	-	-	-	-	0.40	2.08	0.32	-	-	0.28	6.37
7	-	0.32	0.80	-	-	0.84	1.04	0.96	0.56	0.96	0.55	6.87
8	-	0.52	-	-	-	-	0.96	1.00	-	0.08	0.26	6.45
9	-	0.48	-	0.12	-	0.52	0.80	0.64	0.52	0.56	0.36	6.70
10	-	0.44	0.44	0.16	-	-	1.04	-	0.52	0.56	0.32	6.75
11	-	-	-	0.08	0.40	-	0.68	1.00	0.44	0.28	0.29	6.68
12	-	0.32	-	0.20	0.32	-	1.04	0.80	0.40	0.36	0.34	7.53
13	-	-	-	0.60	0.36	0.40	0.68	1.08	0.40	-	0.35	6.51
14	-	0.16	0 40	0.24	0.52	0.40	1.16	0.52	-	0.32	0.37	6.48
15	-	-	-	-	-	-	0.80	-	-	*	0.09	5.37
16	-	0.08	-	-	-	-	-	0.12	-	-	0.02	5.27
17	-	-	-	-	-	-	-	0.40	-	-	0.04	4.97
18	-	-	-	-	-	-	-	0.44	-	-	0.04	6.14
19	-	-	-	0.20	0.68	0.56	0.36	1.08	-	0.44	0.33	5.12
20	-	-	-	-	0.60	0.36	-	0.48	0.40	-	0.18	5.96
21	-	-	-	0.16	0.24	0.48	-	0.52	0.24	-	0.16	6.77
22	-	0.28	0.32	0.12	-	-	-	1.32	0.12	-	0.22	4.50
23	0.44	-	0.48	0.24	1.04	0.84	-	2.24	0.40	0.80	0.65	5.33
24	0.32	0.32	1.52	0.40	0.16	0.40	0.84	-	0.28	0.48	0.47	5.40
25	-	-	0.16	-	0.12	0.24	0.16	1.28	-	-	0.20	5.23
26	-	1.08	-	0.08	0.80	0.64	0.68	1.68	0.40	0.64	0.60	5.88
Average, number of meals, of a total of 72, when salt was added	2	16	12	14	17	23	35	43	18	19		

* Not Recorded .

Table 2

Voluntary Sodium Intake on Days of Regular Diet, in Percent of the Comprehensive Sodium Requirement

Percent of Sodium taken as Condiment	Number of "Meal Days" from which Perventage has been determined
0	55
0-5	23
5-10	40
10-20	17
20-25	5
Total	140

Table 3

Comparison between Values for the Cumulative General Inconvenience Factor and the Voluntary Sodium Intake (Subjects 1-5)

Date	Cumulative Inconvenience Factor	Daily Voluntary Intake in Grams of Sodium per Subject
8.7.59	30	0.22
8.8.59	35.9	0.10
8.9.59	0.4	0.12
8.10.59	15.5	0.21
8.11.59	13.3	0.10
8.12.59	10.7	0.17
8.13.59	27.6	0.19
8.14.59	26.0	0.26
8.19.59	19.0	0.18
8.20.59	18.2	0.12
8.21.59	15.3	0.08
8.22.59	14.7	0.14
8.23.59	37.6	0.44
8.25.59	54.2	0.06
8.26.59	23.8	0.39

Explanation : On 8.24.59 the men were given boiled corn on the cob in plain water without salt -the only time during the entire march- and all added salt to this item.

In the group of subjects 1 - 5 ,which was not urged to eat salt, the average daily sodium addition during the 8 days of eating canned food was 0.05 g sodium per man ,while the cumulative average for 14 days,during which fresh food was eaten, came to 0.2 g sodium daily per man. Correspondingly, the average for the sodium intake during the canned food days (5.96 g) was almost identical with the average for the fresh food days (6.14 g) (see Table 1).

As to the subjects 6 - 10 ,during the days when they were urged to eat salt the salt intake went up to an average of 0.62 g of sodium daily,per man. During the rest of the days spent on the trip the men had an average requirement of only 0.45 g of sodium daily ,per man (see Table 1).

A comparison was arranged between the stress of the heat ,as expressed in a daily cumulative inconvenience factor, and the voluntary sodium intake for the subjects 1 - 5 ,on the days that were identical with regard to the type of food eaten (fresh food). It was clearly demonstrated that there is no parallelity whatsoever between these two sets of values (see Table 3).

No connection was found between the voluntary sodium intake and the cumulative amount of sodium in the daily menu (see Table 1). Equally, no parallelity was found between individual averages for voluntary sodium intake and individual averages for urinary sodium excretion in a 24 hour period. The man who added the least amount of salt to his food as condiment (subject 1) excreted the smallest amount of salt in his urine and the men who added a lot of salt excreted above average amounts in their urine (subjects 7 and 8),but without any fixed ratio between voluntary intake and excretion (see Table 4).

No significant difference was found in the average voluntary sodium intake of four Ashkenazis (Israelis of European origin) (subjects 1,2,7 and 9) : 0.295 g ; or among six non-Ashkenazis (of Oriental origin) : 0.316 g of sodium daily,per man.

Table 4

Comparison between Average Individual Voluntary Sodium Intake and Urinary Sodium Excretion

Subject No	Average Daily Sodium Addition in Grams	Average Sodium Excretion in Urine during a 24 hr Period
1	0.03	1.9
2	0.18	5.9
3	0.24	5.6
4	0.11	3.0
5	0.22	2.1
6	0.32	3.8
7	0.72	4.3
8	0.73	5.6
9	0.25	5.3
10	0.28	3.1

Discussion

The sodium available from addition of salt to food during meal times ,represents a nearly negligibly small part of the daily general sodium intake. In a daily menu containing,on an average ,about 6 g of sodium [1], the average daily sodium addition amounts to only 4.7 % of the total requirement. It follows that there is no point in exaggerating the importance of adding extra salt to food in the summer, on the other hand one should not expect much from denying the addition of salt to food in the case of people who have been put on a low salt diet for therapeutic reasons.

As we can see from Table 4 ,individual differences in voluntary sodium intake are very great. It should be clarified then ,whether there is something in the data offered in this study that would explain the reason for these differences.

If the increased voluntary intake of sodium were a reaction to the lack of sodium ,in this case as the result of perspiration - we would expect that the largest quantity would be required by those in whose urine the smallest amount of sodium was found (based on the assumption that the reduction and disappearance of sodium from the urine is an early and first sign of sodium insufficiency).In fact ,we see a totally reversed picture : The man who added the least amount of salt to his food excreted the least amount of sodium in his urine (Table 1), while those marchers who required a lot of voluntary salt intake were among those who excreted much salt in their urine. As additional proof,we want to point out that no corelation whatever was found between voluntary sodium intake and the environmental heat stress ,in spite of the fact that there was a direct relation between the heat stress and the amount of perspiration given off . It is well to recall here that in the summer of 1960 we collected data on sodium amounts in the urine of workers in Eilat [1]. There was the outstanding case of a worker who excreted 10 g of sodium daily (!) ,which is three times the general average. It turned out that this worker took a large quantity of salt tablets on advice by his physician.

Another interesting possibility may be that the increased voluntary intake is a reaction to the excessive loss of kidney salt. Our data do not lend themselves to agreement with this assumption : 1) Because the voluntary intake is only a negligible part of the general sodium requirement and the urinary excretion is much greater than the total voluntary intake; 2) On the days on which large amounts of salt were lost through perspiration ,or when there was an increase in the extra-cellular volume of fluid , a reduction occurred in the amount of salt excreted in the urine of all participants (including the most prolific salt users) (subjects 3 and 9). Furthermore, there was no change at all in the voluntary salt intake on those days.

Based on what has been said above, we may deduce that the factors deciding the

amount of voluntary salt intake are the taste and composition of the food and, above all, individual eating habits. It may be assumed that the desire for salt is an acquired taste and there is no connection between it and the "needs of the body" [3].

Under the conditions of this test no condition of salt depletion was actually created and there is reason to believe that, under normal conditions in Israel, such a possibility of severe loss of salt because of hard work in a hot environment does not exist (1, 5, 6) . Onthe other hand, the possibility does exist that the above assumptions are not valid for cases where a situation of significant loss of body salt is created artificially [7] .

Conclusion

On the trip Eilat - Hetulla the part of sodium that comes from voluntary salt addition to the food was checked against the general sodium balance. It was found that the voluntary sodium addition amounted to only 4.7 % of the total intake.

No parallelity was found between the voluntary sodium intake and the general sodium intake , the excretion of sodium in the urin or the environmental heat stress.

The most important factor deciding the voluntary sodium intake is the individual food habit ,which depends to some extent on the taste of the food and which is subject to some change due to persuasion.

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