Indian J Physiol Pharmacol 1991; 35(3): 183-186

EFFECTS OF UNDERNUTRITION ON TRANSIT TIME AND BODY WEIGHT OF RATS

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(**Received on June, 30, 1991**)

Abstract : Rats given 50% and 25% of their *ad lib* food intake were taken as undernourished, while those on *ad lib* intake served as controls. Water was given *ad lib* for all rats. Body weight of all rats was measured daily. It showed decrease in undernourished groups but not to the extent expected from calorie intake. Fifty tiny (1-2 mm) orange coloured plastic markers mixed with food were given to all rats, at 11.00 p.m., and were collected from faeces at regular intervals of 1 h each till 80% of markers were obtained. Period (hrs) for collection of 80% markers was taken as total transit time. It showed increase with increased undernutrition (*ad lib* 38.9±2.1 hrs, 50% cal 68.2±5.3 hrs, 25% cal 105.00±3.3 hrs). Delayed transit time in the undernourished by prolonging contact period between food and absorptive surface of intestine probably caused increase in absorption of nutrients and thus counteracted against the loss in body weight of underfed rats.

Key words : undernourishment transit time body weight

INTRODUCTION

Chronically underfed humans or animals have reduced body weight, because of depletion of bodily stores of energy (e.g. glycogen and fat). Two decades ago Collier (1) hypothesised that body weight is proportional to Calorie (food) intake and showed that log Cal intake/log body weight is constant. However later investigations (2,3) showed that "men and rodents lose less weight when they are undernourished" (4) and maintain it at a level more than that expected from Colliers ratio. This "elevated" body weight is thought to be due to reduction in energy expenditure (5,6,7,8). Additionally there appear to be post absorptive metabolic consequences which enhance the deposition of bodily stores (9). but whether absorption of food is also affected by undernutrition is not clear. As digestion and absorption are dependent on the time, the food is allowed to stay in alimentary canal, it was thought worthwhile to investigate transit time of food in the undernourished animals.

METHODS

Adult male Wistar rats housed in individual cages and fed *ad lib* for a period of 2 weeks were used. They were randomly divided into 3 groups based on the amount of calories they received. Group I (n=10) continued on *ad lib* feeding. Group II (n=10) and Group III (n=10) were underfed with 50% and 25% calories respectively of their individual *ad lib* intake. Food was prepared by mixing 1 part of solid food with 1 part of water. Each gram of food thus prepared contained 1.8 calories. Measured amount of food was placed in individual food cups and given to the animals at 4.00 p.m. every day. Water was given *ad lib* for all the rats. Body weight, and food (calorie) intake were measured daily. When the initial steep loss in body weight of underfed rats was stabilised at lower level, the transit time of all rats was investigated.

On the experimental day food cups (not water) were removed at 4 pm from the cages. At about

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10.30 pm fifty opaque plastic markers (1.0 to 2.0 mm in length and breadth and 0.1 mm thick, bright orange in colour, with specific gravity of 0.91) were mixed with a small bolus of food (3 g) and given to individual rats at 11.00 pm after the consumption of which the animals received their respective amount (*ad lib*, 50% and 25%) of food. Faeces were then collected at regular intervals of 1 h each and continued for 17 h period (i.e. till 4 pm next day). The animals were then left undisturbed from 4 pm till 9 am of following day. At 9 am another collection of faeces was made followed by hourly collection till 4 pm on that day. This pattern of collection of faeces was continued till a minimum of 80% of markers were recovered.

The collected faeces were slightly macerated in water, when the markers floated to the surface of water. Orange colour of markers facilitated their identification and counting. Period (in hrs) taken for the first appearance as well as time taken for appearance of 30%, 50% and 80% markers in faeces were noted. The period elapsed for appearance of 80% markers in taken as total transit time.

Student's 't' test was used for statistical analysis.

RESULTS

Actual body weights, computed body weights (expected as per collier) and Calorie intake of 3 groups of rats are shown in Table I. The reduction in calorie intake though caused decrease in body weight of low calorie intake groups (50% and 25%),

TABLE I : Effect of calorie intake restriction on body weight of rats.

Group	*Calorie intake*	*Actual body weight (gms)*	*Computed body weight (as per Collier) (gms)*	*% Increase in body weight= (Actual bw− Computed bw × 100) Computed bw*
Ad lib	46.8±5.3	341.0	341.0	0.0
50%	24.3±2.1	302.4±7.9	116.0	260.7
25%	15.3±1.2	200.3±4.8	58.2	345.3

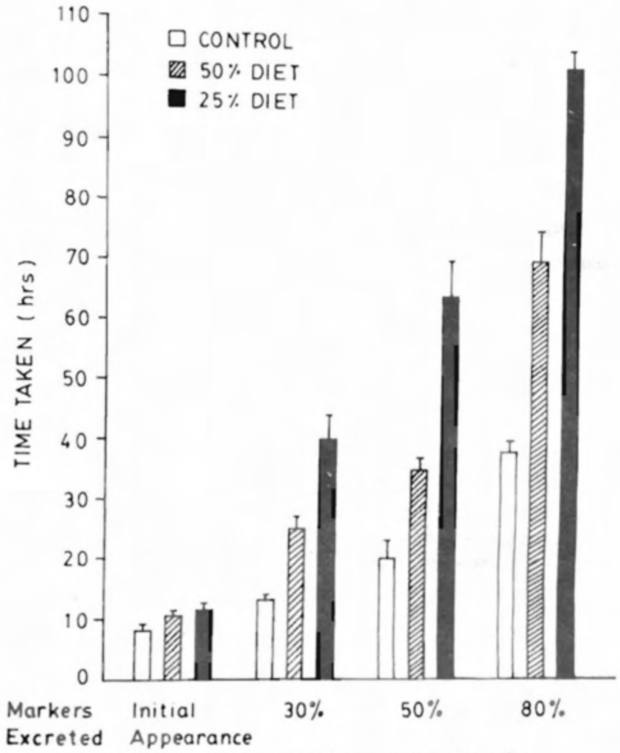

Fig. 1: Effects of undernutrition on food transit time in alimentary canal. It showed increase with increase in undernutrition.

it was not proportional to respective calorie intake. Further, it may be worthy to note that percent increase in actual body weight over computed value (last column) was gradually enhanced with graded calorie deprivation.

The transit time of different % of markers in rats on *ad lib*, 50% Calorie and 25% Calorie groups are shown in Fig 1. Though time (hrs) taken (mean ± SE) for first appearance of markers in the faeces of 25% Cal group (11.8 ± 1.5 h) and 50% Cal group (9.2 ± 0.7 h) and *ad lib* rats (8.1 ± 1.3 h) were almost similar, slight increase in transit time of calorie restricted animals was evident. However the transit time for fixed number of markers (30%, 50% and 80% of 50 numbers given) increased significantly with increased calorie deprivation. For instance, the transit time for 80% markers in 25% calorie group (105.0±3.3 hrs) was significantly more than the transit time shown in 50% cal group (68.2±5.3 h) and in *ad lib* fed rats (38.9 ± 2.1 h).

DISCUSSION

The rats on 50% and 25% Cal represent the undernourished, while those on *ad lib* food served as controls. Fresh food and water were given at 4.00 pm as rats are nocturnal and eat maximally at night. On experimental day the food was withheld for 7 h period (4.00 pm to 11.00 pm) and even then only a small portion of their daily intake which was mixed with markers, was given as initial instalment to ensure that the animals eat immediately and completely. The time at which all the markers were eaten (11.00 pm) was taken as starting point (zero time) for subsequent measurement of transit time. As transit time is the period the food takes to pass through gastro-intestinal tract, and is easy to measure and does not involve handling or discomfort to the animal it is used as a rough and indirect measure of absorption of nutrients.

The present study showing that the body weight of the undernourished is more than the "expected" body weight computed from calorie intake, reinforced our previous observations that both 3 h meal-time (2) and 75% food rats (3) evidenced body weights indentical to *ad lib* rats body weight despite low calorie intake. Clearly the low calorie intake has triggered homeostatic mechanisms which not only oppose the loss in body weight by reduction in BMR (5,6,7) and physical activity (8) but in addition help in building up bodily stores of energy via changes in metabolic pathways (10,11,12). Further the demonstration as early as 1960 that the intestine of undernourished rat (13) but not the intestine of totally starved animal (14) absorbed glucose and L-histidine more efficiently than the intestine of normally fed animal, indicated the involvement of absorption as another homeostatic mechanism in maintenance of body weight. As transit time is enhanced with severity of undernutrition (Fig 1) thus providing greater chance for absorption of nutrients, it is logical to think that on graded lowering of the calorie intake the absorption from the megre food would increase accordingly. This idea is reinforced by the evidence (Table I last column) that precent increase in body weight over the 'expected' body weight of severely undernourished 25% calorie group is more than the increase shown in moderately undernourished 50% calorie group.

But why did transit time increase with undernutrition? It may be due to decreased intestinal motility in hungry animals (15,16) as reported by us earlier.

ACKNOWLEDGEMENTS

The financial support given by SJMC and H Research Society, Bangalore is gratefully acknowledged.

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