

Short Report

Effect of Restricted Feeding Times on the Longevity and Serum Biochemistry of Male Sprague–Dawley Rats

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Abstract

The effect of limiting the daily feeding times on longevity and serum biochemistry was studied in adult male Sprague–Dawley rats. Groups 1H, 6H and 12H received a commercial stock diet for one, six and twelve hours daily, respectively. The control group was fed the same diet *ad libitum*. The final body weight of group 1H was significantly lower, and longevity was significantly greater than in the other three groups. Group 1H consumed only 67% of the intake of the *ad libitum* group. After 36 weeks, the serum albumin of group 1H remained at initial values, and age-related increases in serum lipids were lower than in the other groups. These results suggest that a lower food intake, i.e 67% of *ad libitum* food intake as in Group 1H, may be effective in preventing obesity and aging in male Sprague–Dawley rats.

Introduction

Obesity is a common nutritional disorder in affluent societies and is becoming a problem in many developing countries. It is associated with an increased risk of diabetes, arteriosclerosis and hypertension. Many papers have shown that a lifetime regimen of restricting total food or calorie intake results in a remarkable increase in the length of life, a reduction in incidences of several debilitating and life-shortening diseases [1–5], and a reduction in the accumulation of excess body fat [6].

Wistar and Fischer strain rats have been used extensively in aging studies. Food restriction (60% of *ad libitum* food intake) from early maturity was effective in prolonging the life span and reducing the incidence of several diseases in specific pathogen-free (SPF) Fischer 344 rats [7].

In the present study, adult (weight of 500g; 12–16 weeks of age) Sprague–Dawley rats were used because Sprague–Dawley rats have a higher risk for obesity than other strains, and are useful as a model of obesity in humans. The purpose of this study was to elucidate the effect of limiting daily feeding times on longevity and age-related changes in serum biochemistry in adult male Sprague–Dawley rats.

Materials and Methods

Male Sprague–Dawley rats were purchased from Clea Japan Inc., Tokyo, Japan. Filtered tap water and commercial diet (MF, Oriental Yeast) were available *ad libitum*. Rats were housed in cages kept at a temperature of 25 ± 2 and a relative humidity of $50 \pm 5\%$. A 12 hour light/dark cycle was used throughout

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the experiment (light period, 8:00 a.m.~8:00 p.m.).

Twenty four rats, weighing 500 ± 5 g, were divided into four groups of six animals. Groups 1H, 6H and 12H received a commercial stock diet for one hour (19:00~20:00), six hours (14:00~20:00), and twelve hours (8:00~20:00) daily, respectively. Rats of the control group were fed the same diet *ad libitum*. To obtain data on longevity, all rats were kept until death. Food intakes and body weights were recorded regularly.

The rats were anesthetized with ether, and blood samples were collected from the tail vein on weeks 12 and 36. Serum total protein (TP), albumin (Alb), total cholesterol (TC), triglycerides (TG), and phospholipids (PL) concentrations were measured using an automatic analyzer (Hitachi, Model 7170, Japan).

Statistical analyses of the differences between groups was performed using Duncan's test, and was considered significant when $p < 0.05$, as indicated in the text.

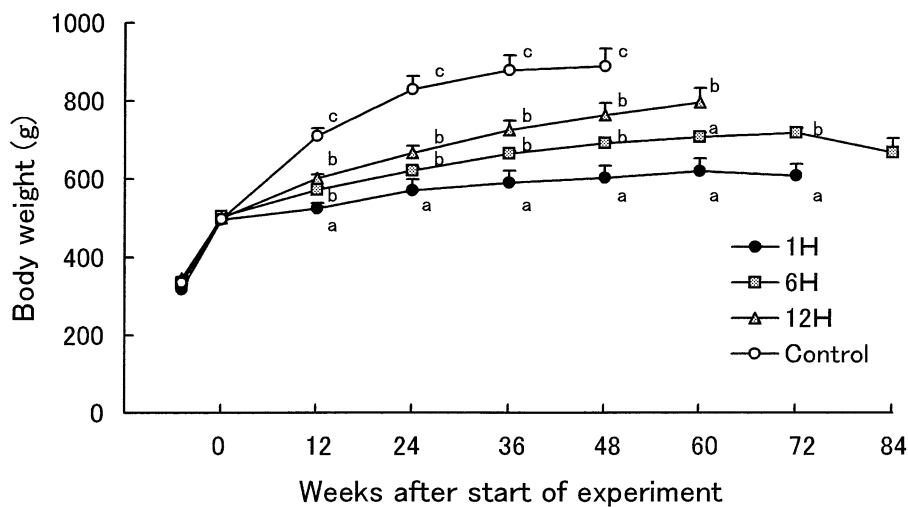


Fig. 1 Effect of limiting daily feeding times on body weights. Values are expressed as mean \pm SEM for six rats. Means with common superscript letters on the same line are not significantly different ($p < 0.05$).

Results

The results on body weights are shown in Figure 1. The experiment was started when the rats had attained body weights of about 500 ± 5 g. The body weight of the control rats increased to about 900g in 48 weeks while those in the restricted feeding groups weighed significantly less. In addition, the rate of weight gain increased with increasing duration of daily feeding time. The body weight of group 1H reached a peak of 620g in 60 weeks which was significantly lower than that of the other three groups.

The results on survival rates are shown in Figure 2. Survival rates were 77 weeks from the start of the experiment for the control group, 92 weeks for group 12H, 107 weeks for group 6H, and 112 weeks for group 1H. The maximum life span in group 1H was 145 weeks.

The results on food intake are shown in Figure 3. The mean food intake in groups 12H, 6H, and 1H were 85%, 72% and 67% of the food intake of the *ad libitum* group, respectively.

Figure 4 shows the percent changes in some serum biochemical parameters. Total protein concentration showed no significant changes in any of the groups during the course of the experiment. Compared to initial values, serum albumin decreased with age in the control group, but remained unchanged in the

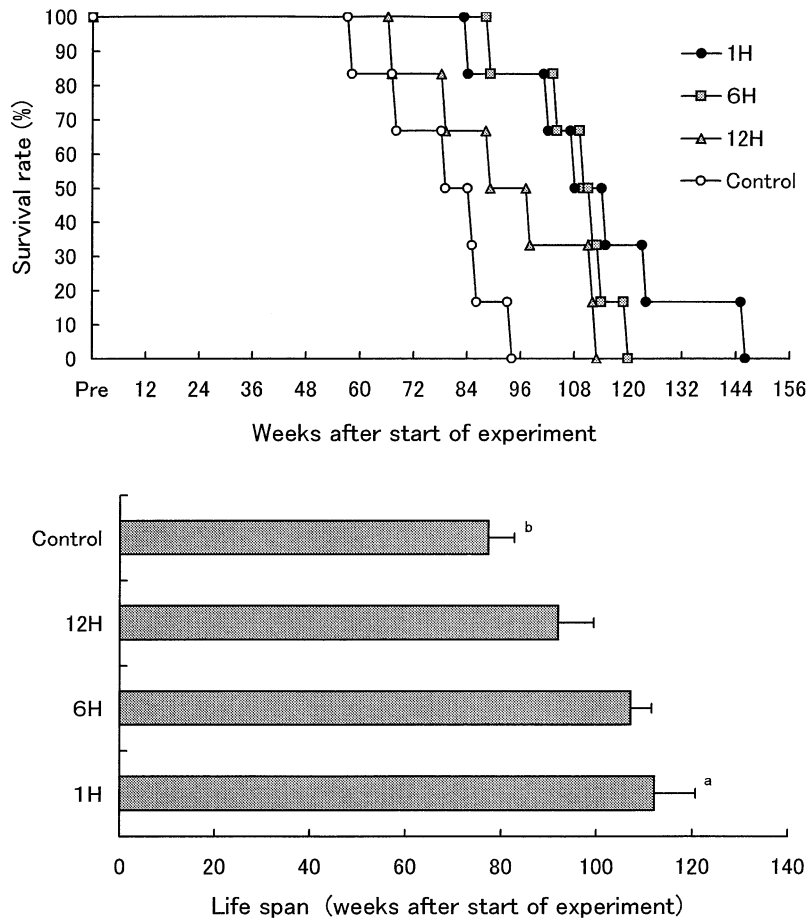


Fig. 2 Effect of limiting daily feeding times on survival curves and life span. Values are expressed as mean \pm SEM for six rats. Means with common superscript letters on the same line are not significantly different ($p < 0.05$).

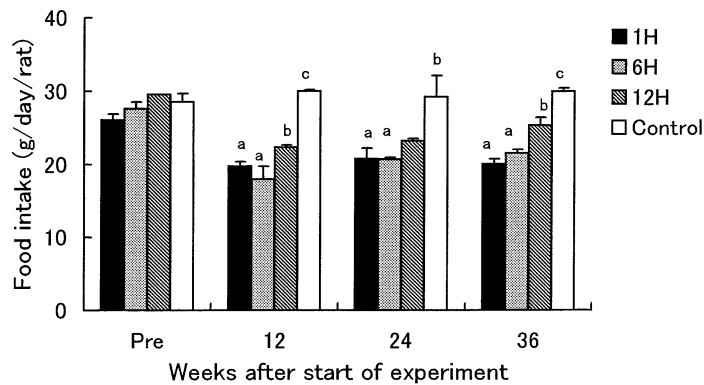


Fig. 3 Effect of limiting daily feeding times on food intake. Values are expressed as mean \pm SEM for six rats. Means with common superscript letters on the same line are not significantly different ($p < 0.05$).

restricted groups. The values at 36 weeks were significantly higher in the three restricted groups compared to the control group. Serum triglycerides, phospholipids and total cholesterol increased with age in all four groups, but at 36 weeks, control group values were significantly higher than those in the restricted feeding groups.

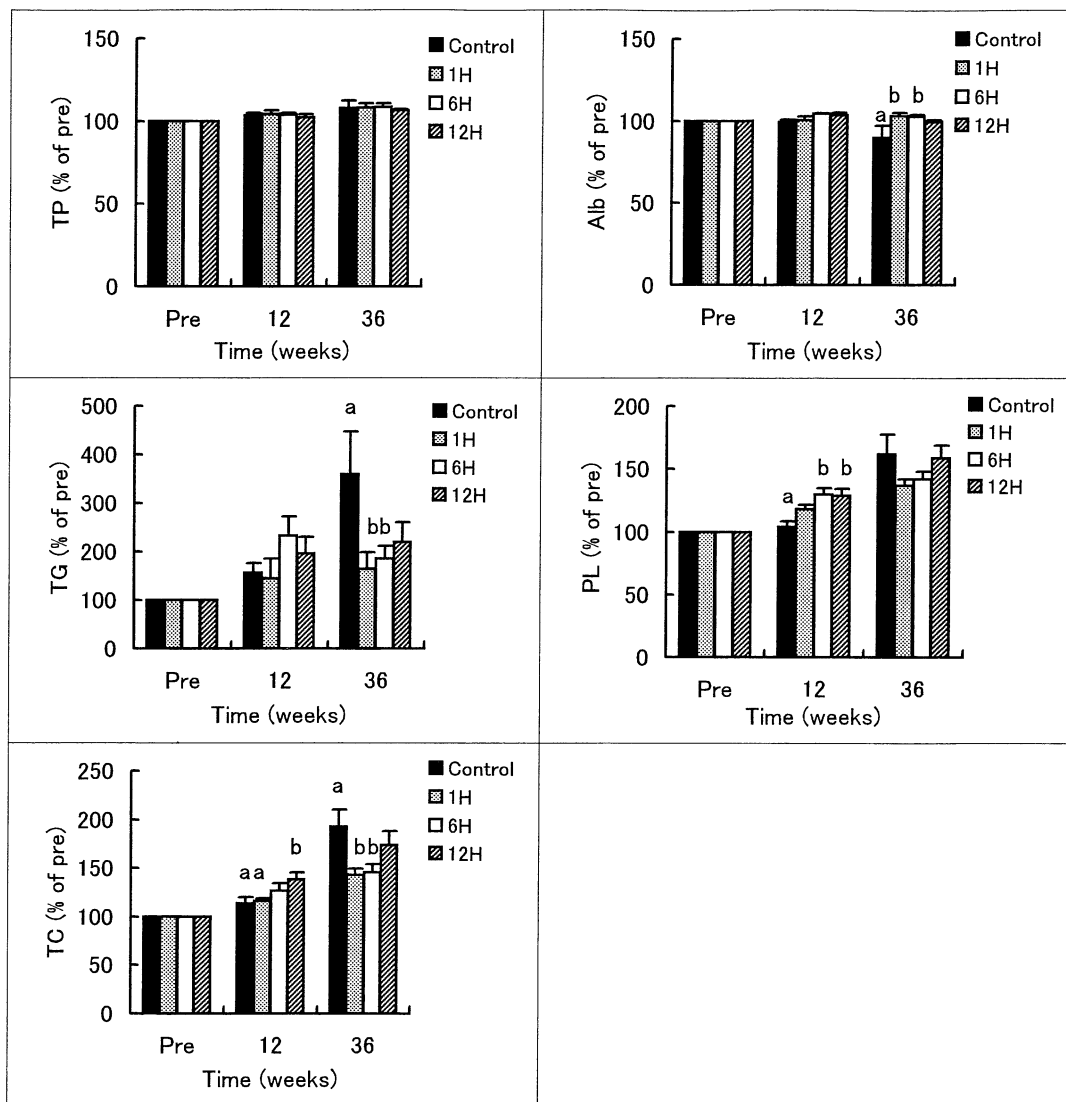


Fig. 4 Effect of limiting daily feeding times on serum total protein (TP), albumin (Alb), triglycerides (TG), phospholipids (PL) and total cholesterol (TC). Values are expressed as mean \pm SEM for six rats. Means with common superscript letters on the same line are not significantly different ($p < 0.05$).

Discussion

Many investigators have suggested that the best dietary regimen for prolonging life in experimental rats is to restrict food intake to 60% of the amount of food consumed by *ad libitum*-fed rats from an early age (approximately 12 weeks of age) [7]. In the present study, when adult Sprague-Dawley rats (body weight: 500g) were given a commercial stock diet *ad libitum* for one-hour daily, they consumed about 67% of the food consumption of *ad libitum*-fed rats. This resulted in a significantly prolonged survival time. Thus, restricting feeding time to one-hour daily produces a life-prolonging effect, even when started from middle age.

The results also showed that, serum albumin decreased with age in the control group, but did not in the restricted groups. Fujita et al. suggested that, though proteinuria in *ad libitum* fed rats has generally been considered to be a spontaneous phenomenon associated with aging, when Wistar strain rats were fed a 50% restricted amount from 90 days of age, the effect was prevention of proteinuria throughout life [8].

In the present study, the control group presumably suffered from proteinuria, but the other three groups which ate 85, 72 and 67% of *ad libitum* food intake, were protected by the lower food intake.

Serum lipids increased with age in all four groups, but at 36 weeks, the control group showed significantly higher serum lipids than the restricted feeding groups. Liepa studied the influences of aging and dietary restriction on serum lipids in male Fischer rats [9]. They reported that serum cholesterol and phospholipid concentrations increase in *ad libitum*-fed rats with increasing age. However, restricting intake to 60% of *ad libitum* food intake did not influence serum lipid levels in young rats but delayed age-related increases in concentrations. Thus, restricting to 60% of *ad libitum* food intake may delay age-related metabolic change in rats. Similarly, in the present study, restricting to 67% of *ad libitum* food intake yielded similar results in adult male Sprague-Dawley rats.

In conclusion, the present study showed that restricting the feeding time to one hour daily (67% of *ad libitum* food intake) prolongs survival time significantly and prevents an age-related decrease in serum albumin and increase in serum lipids, even in middle aged rats. It was concluded that 67% of *ad libitum* food intake (Group 1H) was most effective in preventing obesity and delaying age-related metabolic changes in adult male Sprague-Dawley rats.

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