Food Intake and Body Composition in Novice Athletes During a Training Period to Run a Marathon

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Abstract


The change in diet and body composition was studied in a group of 9 female and 18 male subjects, starting a training program for 18 months with the ultimate goal of running the marathon. Mean daily intakes from 7-day dietary records for macro- and micronutrients were calculated at the start, after 1 year of training, and just before running the marathon. Anthropometric measurements were taken on the same occasions. In males the body fat mass decreased 2.4 kg, while in females no change in body composition was observed over the 18-month training period. Energy intake increased significantly in males from 131 to 159 kJ/kg/day. In women no significant change was recorded (141 to 147 kJ/kg/day). However, in both sexes CHO intake was significantly higher after 18 months (males 63.7–81.7 kJ/kg, females 65.6–81.9 kJ/kg). Also En% CHO increased significantly in males from 48 to 52 and En% in females from 47 to 55. This extra energy intake of CHO in women was covered at the expense of dietary fat. These changes in food habits in both groups are favorable in relation to the nutritional guidelines for better cardiovascular health.

Whether the sex difference found in economizing energy exchange as a response to an intensive training program is based on an increased food efficiency will require further investigation.

Key words

food habits, body composition, training, running, energy balance, food efficiency

Introduction

Physical activity has been encouraged as a general health-promotive measure for several decades. Especially in the last 2 decades an increasing number of epidemiological studies have given evidence on the potential role of daily regular exercise in relation to cardiovascular health (18). This has led to a major drive to promote exercise and physical fitness as part of a comprehensive health promotion. As a result the number of people involved in daily regular exercise is growing. The spectacular increase of subjects participating in a marathon is a sign of these changes in life-style. Beside the health motives no one will deny that the challenge of running a marathon once is a strong motive for every recreational runner.

One expected positive side effect of such an alteration in life-style is the change in food habits and perhaps nutritional status. Physical training prompts an increased energy intake that provides a desired abundance of essential nutrients (23, 24).

At the same time sport participants commonly experience an interest in nutrition because of the desire to optimize the physical performance and in the long run health.

For both goals the generally accepted nutritional guidelines give appropriate information, namely, increased intake of the proportion of carbohydrate (CHO) in favor of fat intake (2, 10, 22).

Up to now, to our knowledge, no information has been available about nutritional practices when untrained subjects start training with the ultimate aim of running a marathon. In the frame of a project (12) about functional changes in male and female volunteers during such a training period, it was possible to study the effects on food habits. Therefore, the aim of this study was to quantify changes in nutritional intake and body composition during a 18- to 20-month training period in novice runners.

Subjects and Methods

From a group of more than 500 volunteers who reacted to an article in local newspapers to participate in the study, a group of 114 subjects were selected. The only selection criterion was an equal male-female ratio in the whole group of volunteers.
The study was split up into three training periods (25 weeks, 20 weeks, and 35 weeks), each terminated with a contest of 15, 25, and 42.195 km, respectively. In the contest period tests were done to study performance and changes in metabolic variables.

From the whole group 30 persons (10 women and 20 men) were randomly selected to register their eating habits. From this group 9 women and 18 men completed the study running the marathon. At the start of the training period, one specific lecture was given about basic nutrition.

Food consumption was assessed on three occasions. First at the start of the study (untrained), 2 weeks before the 25-km contest (1 year later), and 2 weeks before the marathon (1.5 years later). The 7-day food record method was used. The subjects kept a diary in which they noted all food items. Instructions on household measures and description of types of food were given in advance by a trained nutritionist. After returning the diaries they were checked to complete the information on mistakes and uncertainties if any, to estimate portion sizes, and to check household utensils for weight. The information of the diaries was coded and processed with the GVP computer programs (7).

Training

The aim of the training was to run a marathon after about 18–20 months. The subjects trained, from an untrained situation (less than 2 h of training/week) to 4–5 times/week on the average. In the general preparation period, which lasted until 6 weeks before the period of the contest, the subjects trained 3–4 times/week. In the specific preparation period of 6 weeks before the contest they trained 5–6 times/week. The training schedule consisted of increasing the power of endurance and the contest speed. As instruments, endurance runs, speed runs over 1000–3000 m, and intervals of 200–400 m were chosen.

Putting these three elements together a gradual, undulating increase of the amount of training can be accomplished. A period of 3 weeks was used as a training cycle. In the 1st week of the 3-week period, the emphasis in the training was on endurance runs. In the 2nd week it was on the higher pace, and in the 3rd week on speed (12).

In Fig. 1 the scheme of the whole training period is given. Beside the food intake, the following variables were determined on all three measuring occasions: Length (cm), weight (kg), percentage body fat based on the sum of four skinfolds (6), and the maximal aerobic power based on a maximal power (W) during a gradually increasing cycle ergometer test (14). The data were processed statistically with the help of a paired nonparametric t-test (two-way) of separate groups to indicate the changes in variables. When the results of several groups were compared the Mann–Whitney test was used.

Results

In Table 1 the physical characteristics of the group during the whole period of training are given. It appeared that males and females who participated in the present study demonstrated no significant differences from the other.
Tab. 1  Physical and anthropometric characteristics of the males (n = 18) and females (n = 9) at the start of the period of training and before the 25-km race (after 1 year) and the marathon

<table>
<thead>
<tr>
<th></th>
<th>Start</th>
<th>Mean</th>
<th>SD</th>
<th>25-km contest</th>
<th>Mean</th>
<th>SD</th>
<th>Marathon</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>35.8</td>
<td>8.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>178.8</td>
<td>5.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>73.9</td>
<td>7.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>BMI</td>
<td>23.4</td>
<td>2.4</td>
<td>-</td>
<td>-</td>
<td>22.4</td>
<td>1.8</td>
<td>-</td>
<td>22.8</td>
<td>1.8</td>
</tr>
<tr>
<td>%fat</td>
<td>16.6</td>
<td>4.9</td>
<td>-</td>
<td>13.8</td>
<td>3.7</td>
<td>-</td>
<td>13.4</td>
<td>3.2</td>
<td>-</td>
</tr>
<tr>
<td>FFM (kg)</td>
<td>61.4</td>
<td>5.2</td>
<td>-</td>
<td>60.3</td>
<td>4.0</td>
<td>-</td>
<td>61.1</td>
<td>4.3</td>
<td>-</td>
</tr>
<tr>
<td>Fat (kg)</td>
<td>12.8</td>
<td>4.6</td>
<td>-</td>
<td>9.8</td>
<td>3.0</td>
<td>-</td>
<td>10.1</td>
<td>4.3</td>
<td>-</td>
</tr>
<tr>
<td>Max. power (Watt)</td>
<td>272</td>
<td>34</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>305</td>
<td>28</td>
<td>-</td>
</tr>
<tr>
<td>Running time</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>119</td>
<td>12</td>
<td>-</td>
<td>220</td>
<td>26</td>
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</tr>
</tbody>
</table>

For the women the difference was smaller (147 kJ/kg and 168 kJ/kg, resp.) (9).

For both groups there was a significant increase in the total amount of carbohydrate during the whole training period, in males [start/mar: 280—346 g CHO (P = 0.001)] and in females [start/mar: 239—283 g CHO (P = 0.03)].

For the proportional contribution to energy intake (En%) it was demonstrated that women showed a significant decrease of En% protein (25 km/mar: P = 0.03). In the course of the training period, particularly during the last period in both groups, there was a significant increase of En% carbohydrate (M: start/mar: P = 0.043; F: start/mar: P = 0.03). The En% fat intake decreased in females (F: start/mar: P = 0.05).

In Fig. 3 the intake of the main minerals and vitamins during the three periods are given. The heme iron intake did not demonstrate a significant increase during the training periods either in males or females. Only during the first period (start/25 km) did the intake of nonheme iron increase in males (P = 0.007). The delta of iron intake between the two groups were not significant. The females had no change in the intake of calcium during the training period,
whereas in males there was a significant increase (start/25 km: $P = 0.008$). This means that the initial difference between the men and women disappeared in the course of the training period.

Intake of vitamin C increased significantly only in the males (start/25 km: $P = 0.05$), a similar pattern was found for vitamins B1, B2, and B6, such as an increase in males (start/25 km: $P < 0.05$) and a stabilization of the intake of vitamins after the 25-km contest. Because of these differences, a significant increase of vitamin B1 and B6 intake during the training period was found in males compared with females ($P = 0.007$ and $P = 0.041$, respectively).

**Discussion**

The first nutritional requirement for athletic performance is the energetic cost of the increased physical activity. Interesting in this aspect is to follow the energy balance over a longer period as in this study. The effects of endurance training are associated with a decrease in percentage body fat and an increase in percentage lean body mass (8, 11). Especially more obese individuals do not compensate for the increased energy needs during physical training compared with lean counterparts and therefore loose weight (25).

The % body fat of both males and females in this study was within the normal range. Therefore, it was interesting to analyze the gender difference in the change of body composition during the training period as was found by Tremblay et al. (21).

The subjects (males and females) followed a similar training which means that at the end of the training period during the last 6 weeks before running the marathon all subjects ran 80–85 km/week on the average.

During the 1st year of the training period the males lost weight, especially fat mass, whereas in females hardly any change at all was observed. This change in energy reserve in males represented an extra energy expenditure of about 0.2 MJ/day or 2.5 kJ/kg/day, assuming an energetic value of 29 MJ/kg body fat.

From the energy intake values it appeared that the males had an increased energy intake during the first period from 131 to 171 kJ/kg/day. The extra energy from food stores only accounts for an additional increase in energy expenditure of less than 10%. In females the results were completely different. Body composition did not change essentially during the first period, while on the other hand, energy intake was not affected by the increased physical exercise either. These findings are conflicting, assuming that the law of energy conservation is still applicable under these conditions. One has to consider the validity of the measurement of energy intake c.q. food intake and weight change. Considering the last as relatively valid, the conclusion that the measurement of food intake is less valid has to be drawn. In a study of Marr and Heady, the number of recording days to give an 80% correct classification of subjects within the population in the right third of the distribution was 7 days for energy intake (17). Including the relatively small number of females in this study, the results observed can be explained in this way. However, based on the results of the total population, the male subjects decreased significantly in % body fat, while in females no change was observed. If the differences found between males and females is based on a true change in energy intake, the hypothesis of a difference in food efficiency (weight as a function of energy intake) is supported.

It has been suggested that females increase food efficiency in case of energy restriction, as the body seeks to protect and replenish its energy stores. Brownell et al. (2) showed this phenomenon in endurance female athletes while recently v. Raay et al. (19) suggested the same during pregnancy, where an unexplained discrepancy of about 10 kJ/kg/day between energy intake and expenditure was found.

Björntorp and his colleagues demonstrated that this difference in response might be related to the differences in distribution of adipose tissue (1). Male subjects are characterized by a storage capacity in the abdominal region. This fat cell type is more sensitive for release and storage of triglyceride. Leibel et al. found a higher number of beta-receptors in abdominal fat cells which are responsive to exercise (15). In women storage capacity is especially located in the femoral region where alpha-receptors are predominant. In a study of Krotkiwsky and Björntorp with obese men and women, physical training had more effect on body composition in the male type of adipose tissue distribution than in the female distribution (13).

Beside these metabolic differences, there are two other factors which need further attention. A reduction in everyday activities in the female group can result in a constant overall energy expenditure despite increasing running hours. Although no direct measurements were taken, there were no indications that the women did change their everyday activities. Also increasing running efficiency can partly explain the differences found.

Starting from energy expenditure, it is possible to estimate roughly the expected increase in energy need based on the training schedule. Based on a mean running distance of 140 km/3 weeks an extra need of 24 kJ/kg/day can be calculated assuming a running speed of 12 km/h (16). This value is in line with the increase found in energy intake in males of 28 kJ/kg/day and the calculated 2.5 kJ/kg/day energy release from fat stores. These results indicate that the energy intake measurements at least for males give valid mean results. Therefore, the suggested increase in food efficiency in female endurance athletes needs further study to find out the exact magnitude and if so the etiology of this phenomenon.

Analyzing the quality of the food intake and the change of the different macro- and micronutrients over the training period (Fig. 2), it appears that both in males and in females intake of CHO increases. Only in females was this extra CHO intake at the expense of fat intake. For males the absolute amount of energy intake from CHO increased from 63.7 kJ/kg to 81.1 kJ/kg ($P = 0.0032$) during the training period. It is interesting to note that in females this value also increased significantly from 68.0 kJ/kg to 81.9 kJ/kg ($P = 0.0048$) despite the fact that total energy intake was not significantly affected.
These findings support the well-documented important role of carbohydrate to perform prolonged exercise (4, 20). Despite the fact that the results in the female group suggest an increasing food efficiency, the absolute amount of energy from CHO intake per kg is comparable in both groups running the same distance per week.

Considering the initial level of fat intake of both groups, one may conclude that these levels are lower than the average intake of the Dutch population, which has an intake of about 43 En% fat. Perhaps these subjects are already aware of taking a prudent diet with lower fat intake in favor of carbohydrate. Nevertheless, starting on such a training program CHO intake is further increased to the advised level at the expense of fat according to the nutritional guidelines for better cardiovascular health.

With respect to mineral and vitamin intake, the increase during the training in males especially during the first period can be explained by the increased food intake. Nutrient density per unit energy did not change significantly. However, in the female groups the intake of nonehme iron and vitamin C increased in spite of a constant food intake. The intake of bread, vegetables, and pastry products was increased in favor of butter/margarine and fatty meat. This positive change led to an increased nutrient density for iron and vitamin C. On the other hand, the intake of calcium, heme iron, and the B vitamins remained similar over the whole training period.

The intake of calcium is comparable to the results found in the study with elite athletes in the Netherlands (9); for the women it was about 200 mg lower than was found in a study in highly trained female runners in the United States (5). For iron this difference was greater (17 mg in this study vs 41.9 mg in the study of Deuster (5)). However, for both minerals the supplement-derived mineral intake was high in these highly trained female runners. In our study, this extra intake of iron was not taken into account. Based on the results of the non-supplement group in the study of Deuster, iron intake in our group did not differ essentially.

In conclusion, it appears that as a response to an intensive training program there is a sex difference in economizing energy exchange. Males increase energy intake and energy release from the body fat stores. In females no change in the energy intake and energy stores was observed, although they ran the same training distance.

An increased food efficiency in women is a possible explanation for this different response. However, both males and females do increase the energy intake from carbohydrate. In males the extra energy needs were covered by an extra intake of carbohydrate. In women this extra energy intake from carbohydrate was covered at the expense of dietary fat. For both groups these changes in food habits led to a diet which can be described as a prudent diet in the light of the nutritional guidelines for better cardiovascular health.

References


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