The association between vigorous physical activities and fat deposition in male adolescents

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ABSTRACT

DIONNE, I., N. ALMÉRAS, C. BOUCHARD, and A. TREMBLAY. The association between vigorous physical activities and fat deposition in male adolescents. Med. Sci. Sports Exerc., Vol. 32, No. 2, pp. 392–395, 2000. Purpose: The aim of this study was to investigate the association between participation in vigorous physical activities (VPA) and indicators of adiposity and fat distribution in male adolescents. Methods: Subjects were classified on the basis of the number of reported 15-min periods over 3 d during which VPA were performed. Results: Body weight, fat mass, body mass index, sum of six subcutaneous skinfolds, trunk and extremity skinfolds, and trunk to extremity skinfolds ratio (T/E ratio) were all significantly and inversely related to a higher VPA participation. Moreover, T/E ratio was significantly lower in the subgroup reporting a mean of 7.8 15-min periods of activity for 3 d (equivalent to a mean of 39 min d⁻¹) compared with subjects reporting no participation. This decrease in T/E ratio was more pronounced in subjects reporting a mean of 13.6 15-min periods of VPA for 3 d. Conclusion: These observations reinforce the idea that excess abdominal fat accumulation can be prevented by regular participation in vigorous physical activities. Key Words: BODY FAT, PHYSICAL ACTIVITY RECORD, YOUTH, EXERCISE, OBESITY

The last century has been characterized by a marked decrease in energy expenditure at work and for transportation (5). Even though the promotion of leisure time physical activity has increased, the constant increase in the prevalence of obesity suggests that total energy expenditure, at a given body weight, is still lower compared to a century ago.

Because voluntary physical activity energy expenditure is the most variable component of total energy expenditure (8), its implication in maintaining energy balance is of major importance. A low energy expenditure is associated with a positive energy balance that favors obesity (18). It has been suggested that the prevalence of obesity has been increasing over the last few decades because of the decrease in voluntary energy expenditure (5). Only between 1982 and 1992, the prevalence of obesity has augmented by 4% in men from Finland (7). In addition, Kuczmas rski et al. (14) reported an increase in the prevalence of obesity of 8% and 9% in American men and women between 1984 and 1994. In Canada, 49% of adults were overweight (≥25 kg·m⁻²) in 1995 (4). Unfortunately, the problem of obesity often starts at a younger age as indicated by a parallel increase of obesity in adolescents. In 1980, there was 30% more obese American teenagers than in 1960 (9). In addition, there was a tremendous increase of pronounced obesity of 64% in the same population during the same period of time (10).

It has been demonstrated that 70–80% of obese adolescents continue to be obese as adults (13). Because of the known health problems associated with obesity (17), it would be of primary importance to prevent adulthood obesity by diminishing the prevalence of this state in earlier years. Our experience has shown that practicing vigorous activities on a regular basis is associated with lower subcutaneous skinfold thicknesses and central fat deposition (21,23) by favoring a negative energy balance in adults (10). However, other studies conducted in male adolescents that did not consider the intensity of exercise found no correlation between the amount of time spent at physical activity participation and the sum of six skinfolds (12) or fatness (1).

In the present study, we thus focused on vigorous physical activity and investigated the impact of the time allocated to such activities on body composition and fat distribution indices in male adolescents. We compared fat mass, percent body fat, sum of 6 skinfolds, and trunk/extremity skinfolds ratio in subjects reporting no participation in vigorous physical activities to subjects reporting different amounts of time spent in vigorous physical activities measured using a 3-d physical activity record.

METHODS

Subjects. Body weight, fat mass (FM), body mass index (BMI), sum of 6 skinfolds (SUM6), sum of trunk (TRUNK) and extremity (EXT) skinfolds, and trunk to
extremity skinfolds ratio (T/E ratio) were obtained in 373 male adolescents aged 14.5 ± 3.3 yr. The written consent of parents was obtained before testing, and the approval of the Laval University Ethics Committee was also obtained. The physical characteristics of subjects were as follows: body weight = 50.0 ± 15.1 kg, height = 159.8 ± 16.0 cm.

Subjects were classified on the basis of their participation in vigorous physical activities, which was assessed by using the physical activity record developed by Bouchard et al. (2). Subjects had to complete the physical activity diary for 3 d including 2 weekdays and 1 weekend day. Each day was divided in 96 periods of 15 min each. For each 15-min period, subjects had to code the main activity performed on a scale from 1 to 9. Appendix 1 presents examples of activities in each category, along with their categorical values and the energy cost retained for computational purposes. The latter value corresponds to approximately the median energy cost derived from a comprehensive review of literature. When an activity not listed in Appendix 1 was reported, subjects were instructed to report the categorical value closest to activity of comparable intensity. The reliability and the validity of the record were previously reported (2).

Participation in vigorous physical activity (VPA) was estimated as the number of periods graded 8 or 9, and groups were classified according to the number of periods of VPA for the 3 d (Table 1). Except for group 0 that was selected for its inactivity (no VPA), the subdivision of other groups was fixed to maintain a difference of about 15 min of VPA per day between each group. We also tried to preserve a minimal sample size in each group. We then compared subjects of observation (group 0) with subjects who reported various numbers of periods at level 8 or 9 (groups 1–5). We also tried to preserve a minimal sample size in each group. We then compared subjects who reported no period of activities graded 8 or 9 for the 3 d of observation (group 0) with subjects who reported various numbers of periods at level 8 or 9 (groups 1–5).

**Body composition and fat distribution.** Skinfold thicknesses (triceps, biceps, subscapular, suprailiac, abdominal, and medial calf) were measured using a Harpenden (British Indicators Ltd., England) skinfold caliper following the recommendations of the International Biological Pro-

**TABLE 2. Body composition characteristics of male adolescents.**

<table>
<thead>
<tr>
<th>Group</th>
<th>Weight (kg)</th>
<th>BMI (kg·m⁻²)</th>
<th>FM (kg)</th>
<th>TRUNK (mm)</th>
<th>EXT (mm)</th>
<th>SUM6 (mm)</th>
<th>T/E ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>51.2 ± 15.6</td>
<td>19.3 ± 2.9</td>
<td>6.6 ± 4.5</td>
<td>25.5 ± 14.1</td>
<td>21.3 ± 11.5</td>
<td>46.8 ± 24.5</td>
<td>1.26 ± 0.50</td>
</tr>
<tr>
<td>1</td>
<td>53.0 ± 15.3</td>
<td>19.7 ± 3.1</td>
<td>7.2 ± 4.3</td>
<td>26.7 ± 15.6</td>
<td>21.7 ± 8.6</td>
<td>48.4 ± 22.7</td>
<td>1.23 ± 0.40</td>
</tr>
<tr>
<td>2</td>
<td>49.6 ± 15.3</td>
<td>19.3 ± 2.6</td>
<td>6.6 ± 4.1</td>
<td>26.5 ± 16.2</td>
<td>22.8 ± 12.6</td>
<td>49.2 ± 27.5</td>
<td>1.23 ± 0.52</td>
</tr>
<tr>
<td>3</td>
<td>47.0 ± 15.3</td>
<td>18.7 ± 2.6</td>
<td>6.9 ± 4.1</td>
<td>26.5 ± 11.3</td>
<td>20.3 ± 7.6</td>
<td>41.9 ± 17.6</td>
<td>1.08 ± 0.36</td>
</tr>
<tr>
<td>4</td>
<td>46.4 ± 15.3</td>
<td>18.7 ± 2.5</td>
<td>5.6 ± 3.4</td>
<td>23.4 ± 13.5</td>
<td>21.1 ± 7.3</td>
<td>44.5 ± 20.2</td>
<td>1.09 ± 0.34</td>
</tr>
<tr>
<td>5</td>
<td>39.6 ± 13.2</td>
<td>16.8 ± 1.8</td>
<td>5.4 ± 3.4</td>
<td>15.9 ± 4.5</td>
<td>16.7 ± 4.3</td>
<td>32.6 ± 7.2</td>
<td>0.99 ± 0.30</td>
</tr>
</tbody>
</table>

Values are means ± SD.

**RESULTS**

Table 1 shows the number of 15-min periods of vigorous physical activity over 3 d reported by each group of subjects as well as the corresponding time on a daily basis. As indicated above, we repeatedly compared the inactive group to each active group reporting a progressive increase in vigorous physical activity participation. The most active group (group 5) was composed of 13 individuals who were exceptionally active since their mean daily participation in vigorous physical activities approached 70 min per day.

Variations in body weight, BMI, SUM6, TRUNK, EXT, and T/E ratio between groups are presented in Table 2. In general, these morphological indicators all tended to decrease with increasing physical activity participation, particularly in group 5.

Figure 1 illustrates between-groups variations in body weight, FM, and BMI adjusted for age. It shows that group 5 displayed a significantly lower body weight and BMI than the inactive group. Figure 2 illustrates that SUM6, TRUNK, EXT, and T/E ratio were also significantly lower in the very active in comparison to the sedentary group. On the other hand, group 0 was not different from groups 1 and 2 for T/E ratio, but group 3 had a significantly lower value than group 0. To ascertain this relationship, we computed the correlations between T/E ratio and time spent at vigorous physical activity, and it was found that T/E ratio was negatively and significantly correlated to VPA (Table 3). Other correlations demonstrated that body weight and body composition...
variables were all significantly correlated with each other. Body weight, BMI, SUM6, TRUNK, and EXT were also significantly correlated to T/E ratio, suggesting that when males adolescent displayed higher body weight and skinfold thicknesses, they also tended to exhibit a propensity to accumulate more abdominal fat.

**DISCUSSION**

The present study compared different body composition indicators between a group of subjects reporting no vigorous physical activity participation (group 0) and subjects reporting different amounts of time spent at voluntary vigorous physical activities. Body composition variables were adjusted for age to correct for the effect of maturation on body composition. The most significant observations of this study was that the T/E ratio was significantly lower in groups 3 and 5 compared with group 0 and that all other variables (except for fat mass) were significantly lower in group 5 than in group 0. Specifically, this means that a higher rate of VPA is linked with a lower body fat accumulation, especially in the trunk area. However, all the variables were similar for groups 0 and groups 1, 2, and 3 (except for T/E ratio). Indeed, it seems that 0 or 25 min of VPA had the same effect on body fat accumulation and that 68 min induced a significant effect on body fat accumulation and distribution. Because groups 3 and 4 presented similar T/E ratio but group 4 included only 24 subjects (compared with 46 in group 3), the absence of significant level for T/E ratio between group 0 and 4 is likely to be caused by a lack of statistical power. Figure 1 and Table 2 also illustrates a decrease, although not statistically significant, in the fat mass of adolescents classified in groups 4 and 5. However, the under-water weighing technique was performed in only 61.5% and 75% of the subjects in groups 4 and 5, respectively, which reduces the statistical power of the comparison with other groups.

Taken together, our results provide evidence that regular physical activity participation has the potential to prevent body weight gain as well as a preferential storage of subcutaneous fat in the trunk area. Our data are in accordance with those recently reported by Janssen et al. (11), who found that under feeding conditions where exercise-training induced no changes in body weight, the decrease in visceral fat area exceeded 20% of the initial level. This is also in agreement with our previous experience demonstrating that exercise-training promotes a significant reduction in visceral fat in young male adults (3,21). In the present study, we did not perform direct measurements of visceral fat deposition, but it appears that vigorous physical activity is associated with a decrease in abdominal fat because the T/E ratio was significantly lower only in very active subjects and is likely to also affect visceral fat in adolescents as well.

It was disappointing to note that only 12% of the total sample of subjects practices VPA for more than half an hour a day and only 3.5% for more than 1 hour a day in comparison with 30% who do not participate in such activities at all. The ongoing increase in the prevalence of obesity in adolescents is likely related to the inactivity of this population.

It is known that in male subjects, fat is preferentially stored in the abdomen (15). It has also been demonstrated that upper-body fat accumulation is associated with greater
risks to develop diabetes, hypertension, and gallbladder diseases (19). The promotion of physical activity is thus highly relevant in order to facilitate the prevention of upper-body fat accretion during adolescence in male subjects and future health problems.

We should be aware of the important influence of the diet on body composition. It was previously demonstrated that intense exercise has the potential to induce a negative energy balance (10) as long as exercise is accompanied by a low-fat diet (6,22). This suggests that it would be useful to promote a healthy lifestyle combining healthy food habits together with vigorous physical activity participation. It would be of great interest to investigate the effect of such a combination on body composition during adolescence, because diet was not considered in this study. Moreover, overall energy expenditure, including physical activities of lower intensity, would also be an interesting issue.

In conclusion, this study demonstrated that VPA participation is associated with variations of body weight and body fat distribution in male adolescents. We demonstrated that performing 13.6 15-min periods of VPA for 3 d is associated with a lower body weight and subcutaneous fat mass in male adolescents and that a mean of 7.8 15-min periods of VPA participation for 3 d is associated with a lower T/E ratio. Thus, the promotion of physical activity at a young age, as well as for youth of all ages, is of major importance, considering its positive impact on body fat distribution and health status.

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REFERENCES


### TABLE 3. Correlation coefficients between physical activity participation and body composition markers in male adolescents.

<table>
<thead>
<tr>
<th>VPA (Time)</th>
<th>Body Weight</th>
<th>FM</th>
<th>BMI</th>
<th>SUM6</th>
<th>TRUNK</th>
<th>EXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight</td>
<td>–0.07</td>
<td>0.00</td>
<td>0.37**</td>
<td>0.04</td>
<td>0.80**</td>
<td>0.29**</td>
</tr>
<tr>
<td>FM</td>
<td>–0.04</td>
<td>0.80**</td>
<td>0.79**</td>
<td>0.01</td>
<td>0.45**</td>
<td>0.97**</td>
</tr>
<tr>
<td>BMI</td>
<td>0.01</td>
<td>0.45**</td>
<td>0.79**</td>
<td>–0.01</td>
<td>0.48**</td>
<td>0.73**</td>
</tr>
<tr>
<td>SUM6</td>
<td>0.01</td>
<td>0.48**</td>
<td>0.73**</td>
<td>0.04</td>
<td>0.35**</td>
<td>0.77**</td>
</tr>
<tr>
<td>TRUNK</td>
<td>0.04</td>
<td>0.35**</td>
<td>0.77**</td>
<td>0.04</td>
<td>0.36**</td>
<td>0.08</td>
</tr>
<tr>
<td>EXT</td>
<td>0.01</td>
<td>0.36**</td>
<td>0.08</td>
<td>0.38**</td>
<td>0.30**</td>
<td>0.49**</td>
</tr>
<tr>
<td>T/E ratio</td>
<td>–0.11*</td>
<td>0.36**</td>
<td>0.08</td>
<td>0.38**</td>
<td>0.30**</td>
<td>0.49**</td>
</tr>
</tbody>
</table>

* P < 0.01; ** P < 0.0001.