Eating Patterns and Composition of Meals and Snacks in Elite Canadian Athletes

Kelly Anne Erdman, Jasmine Tunnicliffe, Victor M. Lun, Raylene A. Reimer

The purpose of this study was to determine the meal- and snack-eating frequency and the nutritional composition of each eating occasion of Canadian high-performance athletes during training. Athletes from 8 Canadian Sport Centres prospectively completed 3-d dietary records including all food, fluid, and supplements consumed. The time of consumption and whether the consumption was a meal or snack were also identified. The dietary records were analyzed for energy (kcal) and macronutrient intake (carbohydrate, protein, and fat) and compared based on gender, age, meal vs. snack, and training vs. rest days. Three hundred twenty-four athletic subjects (64% female and 36% male) completed the study. On average, the athletes ate 4.8 ± 0.8 times daily. Nearly all athletes consumed 3 daily meals of breakfast (98.9%), lunch (97.9%), and dinner (98.7%), with few having snacks: 57%, 71.6%, and 58.1% of athletes consumed an a.m., p.m., and evening snack, respectively. Training-day meal frequency did not differ from that during rest days; however, fewer snacks were consumed on rest days. A.m. and p.m. snacks were consumed significantly more often on training days than rest days. Overall, snacks contributed 24.3% of total daily energy intake. Few dietary variations were discovered between genders, while the youngest athletes (<18 yr) ate less often, especially their morning snack, than the older athletes. In conclusion, Canadian high-performance athletes self-adjusted their energy intakes on training vs. rest days primarily by snacking less and reducing their carbohydrate and protein intakes on rest days, yet they consistently ate regular meals.

Keywords: eating frequency, eating occasions, nutrition

Specific recommendations for daily energy and carbohydrate, protein, and fat intake have been established for athletes participating in a variety of physical activities (e.g., endurance and strength training; American Dietetic Association [ADA] et al., 2009; Burke & Deakin, 2010; Economos, Bortz, & Nelson, 1993; Rosenbloom, 2000). These recommendations are typically expressed relative to a percentage of total energy intake (TEI) or relative to body weight (e.g., carbohydrate g · kg⁻¹ · day⁻¹), which is the more universally accepted way to express intakes and requirements (ADA et al., 2009). Guidelines related to the composition and amount of immediate preexercise meals and snacks, as well as nutritional strategies for postexercise recovery, have also been proposed (ADA et al., 2009; Burke & Deakin, 2010; Hawley & Burke, 1997; Houtkooper, Abbot, & Nimmo, 2007; Ivy, 2001; Ivy, Katz, Cutler, Sherman, & Coyle, 1988; Jentjens & Jeukendrup, 2003; Kerkisch et al., 2008; Rosenbloom, 2000).

Estimates of total daily macronutrient and micronutrient intakes by athletes have been reported extensively throughout the literature for a variety of sports (Beshgetoor & Nichols, 2003; Burke, 2001b; Clark, Reed, Course, & Armstrong, 2003; de Sousa, Da Costa, Nogueira, & Vivaldi, 2008; Farajian, Kavouras, Yannakoula, & Sidossis, 2004; Garcia-Roves, Terrados, Fernandez, & Patterson, 2000; Heaney, O'Connor, Gifford, & Naughton, 2010; Hinton, Sanford, Davidson, Yakushko, & Beck, 2004; Houtkooper et al., 2007; Jenalagadda, Ziegler, & Nelson, 2004; Juzwiak, Amancio, Vitalle, Pinheiro, & Szejnfeld, 2008; Lun, Erdman, & Reimer, 2009; Martin, Martin, Collier, & Burke, 2002; Maughan, 1997; Mullins, Houtkooper, Howell, Going, & Brown, 2001; Owyerwa, Kiplamai, Tuitoek, Boit, & Pitsiladis, 2004; Peters & Goetzsche, 1997; Petersen et al., 2006; Paschoal & Amancio, 2004; Schokman, Rutishauser, & Wallace, 1999; Sugiuara, Suzuki, & Kobayashi, 1999; van Erp-Baart, Saris, Binkhorst, Vos, & Elvers, 1989). However, information on the distribution of energy and macronutrient intake during training and competition and the frequency of meals and snacks is limited in general (Burke et al., 2003; Butterworth, Nieman, Butler, & Herring, 1994; Jensen, Zaltas, & Whitam, 1992; Nogueira & Da Costa, 2004) and nonexistent for Canadian elite athletes. Furthermore, many of the studies reporting food-frequency data of athletes provide a single value for total daily snack consumption versus analysis of individual snacks (Aerenhouts, Hebbelinck, Poortmans, & Clarys, 2008; Garcia-Roves, Fernandez, Rodriguez, Perez-Landale, & Patterson, 2000; Leblanc, Le Gall, Grandjean, & Verger, 2002; van Erp-Baart et
Certain assumptions can be made regarding the eating patterns of athletes, including that they have higher total energy requirements than inactive individuals due to greater rates of energy expenditure, the thermic effect of activity, and increased resting metabolic rate related to differences in body composition, that is, greater muscle mass (ADA et al., 2009; Burke, 2001a; Burke & Deakin, 2010; Hawley & Burke, 1997; Rosenbloom, 2000). It may also be supposed that to meet these additional energy demands, athletes generally eat more frequently by incorporating snacks between meals or increased energy density within meals compared with sedentary populations (Burke & Deakin, 2010; Hawley & Burke, 1997).

Uncertainty over the advantages and disadvantages of eating frequently and the lack of precise recommendations from sport nutrition experts on this topic present a practical challenge for those who advise athletes about their daily dietary patterns during training and competition, especially if athletes wish to modify their body composition. Furthermore, regular monitoring of the occasions on which athletes consume meals and snacks has the potential to provide dietitians with important information regarding the patterns of meal and snack intakes to meet energy and macronutrient goals (on active and inactive days), as well as to assess the adequacy of pre- and postexercise intakes.

Therefore, the purpose of this study was to compare the eating frequency and the nutritional composition of each eating occasion of Canadian high-performance athletes on training versus rest days.

Methods

This study received ethical approval from the Conjoint Health Research Ethics Board of the University of Calgary, Calgary, Alberta, Canada. Male and female athletic subjects were recruited by dietitians from eight Canadian Sport Centres across Canada: Victoria, Vancouver, Calgary, Saskatchewan, Manitoba, Ontario, Quebec, and Atlantic (representing the Atlantic provinces). Approximately 2,800 athletes were affiliated with these Sport Centres, competing at national or international levels.

After athletes voluntarily completed consent forms, dietitians from each Sport Centre scheduled individual interviews or provided instructions during workshops on how to track food and supplement intake over a 3-day period. In an open-ended format, athletes indicated the time of day they consumed their food, fluids, and supplements on their food records such that specific meals and snacks were identifiable. The dietitians briefly reviewed the subjects’ food records for clarity before submitting them for nutritional analysis.

Data were collected from November through April. Completed food records were forwarded to two dietitian research assistants (French and English speaking) who analyzed the raw data using Food Smart nutrition software (Version 2, Envision Health Networks Inc.). The subjects’ food records were analyzed for energy and macronutrient (vitamins, minerals) intakes for each day, as well as for each meal and snack. Statistical analysis of the dietary intakes was performed using the Statistical Package for the Social Sciences version 19.0 (SPSS Inc., Chicago IL, USA).

Results for energy and macronutrient intakes are expressed as $M \pm SD$. Comparisons of male versus female and training- versus rest-day intakes were performed using paired-samples $t$ tests. Age categories were compared using one-way ANOVA with a Bonferroni post hoc test to determine which groups were different, if applicable. For daily intake related to type of meal/snack according to gender, comparisons were made using general linear-model repeated-measures ANOVA with a Greenhouse-Geisser correction to correct for sphericity. The Wilcoxon signed-rank test was used to examine meal frequency on training versus rest days. A significance level of .05 was used for all types of statistical analyses.

Table 1  Subject Characteristics, $M \pm SD$

<table>
<thead>
<tr>
<th></th>
<th>Males ($n = 103$)</th>
<th>Females ($n = 181$)</th>
<th>Total ($N = 284$)</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>21.3 ± 5.5</td>
<td>20.5 ± 5.0</td>
<td>20.6 ± 5.4</td>
<td>.399</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>179.6 ± 8.5*</td>
<td>169.9 ± 7.3*</td>
<td>173.3 ± 9.1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>75.6 ± 12.3*</td>
<td>64.6 ± 9.3*</td>
<td>68.4 ± 11.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Training days (out of possible 3)</td>
<td>2.3 ± 0.7</td>
<td>2.5 ± 0.7</td>
<td>2.4 ± 0.7</td>
<td>.100</td>
</tr>
</tbody>
</table>

*Significant difference between males and females ($p < .05$); data missing from $n = 23$. 

Eating Patterns, Meals, and Snacks

Table 1  Subject Characteristics, $M \pm SD$

<table>
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Athlete Characteristics

The demographics of the 324 athletic subjects who completed 3-day dietary logs are summarized in Table 1 and have been previously reported (Lun et al., 2009). Unfortunately, there were insufficient numbers of athletes from each of the eight Canadian Sport Centres to compare results across centers, so data were pooled for analysis based on age and gender. There were more females ($n = 201$) than males ($n = 114$), and both height and weight but not age ($M = 20.6 \pm 5.4$ years) differed between genders ($p < .001$, $p < .001$, respectively), with 78% of
the athletes being less than 25 years of age. During the 3
days of intake tracking, the subjects trained on average
2.43 ± 0.7 days with no significant differences between
males and females. Athletes represented 41 different
sports (26 summer and 15 winter), with soccer (football),
ice hockey, volleyball, and long-track speed skating as
the four most prevalent.

Dietary Analysis
Energy and macronutrient intake are presented in Table
2, where each day of each athlete’s intake was included
in the data for analysis, rather than assessing the average
of 3 days of intake for each athlete. Dietary intake in the
current study included any supplements consumed.
Males had significantly higher caloric intake (p < .001),
as well as higher absolute intake of protein (p < .001),
fat (p < .001), and carbohydrates (p < .001) per day and
more protein on a g · kg–1 · day–1 body-weight basis, than
females, p < .001 (Table 2). Athletes in the youngest age
category had a lower caloric (p < .001), fat (p < .001), and
protein intake (p < .001) than the older groups.

Training Versus Rest Days
As seen in Table 2, the athletes consumed significantly
more energy on training days than on rest days, p = .002.
Their diets were significantly lower in protein (g/day, p
= .002, g · kg–1 · day–1, p = .002) and carbohydrates (g/
day, p < .001, g · kg–1 · day–1, p = .001, %TEI, p = .039)
yet proportionately higher in fat (%TEI, p = .008) on
rest days.

Daily energy and macronutrient intake, according to
eating occasion for females and males, is shown in Tables
3 and 4. Statistical analysis was completed within and not
between genders. The trends in meal patterns for males
and females were similar.

For female athletes, energy intakes from the three
main meals were significantly different from each other
(p < .001) and from each of the three snacking occasions,
p < .001 (Table 3). Their afternoon p.m. snack provided
significantly more energy (p < .001) and macronutrient
content than the a.m. (p < .001) and evening snacks (p
< .001). Dinner contained the most calories (p < .001),
with significantly more energy from protein (p < .001)
and fat (p < .001) than all the other eating opportunities.
Morning and evening snacks contained the least energy
(p < .001) and macronutrient content (p < .001).

Similarly, energy intake across the meals consumed
by male athletes was also statistically different, p < .001
(Table 4). For males, however, although the p.m. snack
contained the highest energy of the three snacks, it was
not significantly different from the a.m. snack. Similar to
females, the largest source of energy for males was from
the dinner meal, which had significantly more protein
than the breakfast and lunch meals (p < .001).

Daily meal frequency was calculated as an average
of whether a meal was consumed at each opportunity
(i.e., three main meals, three snacks; Table 5). Overall
frequency of eating occasions was significantly greater
on training days than rest days (p < .001), as was snack
consumption (p < .001) but not the number of average
meals daily. Although both males and females had fewer
eating occasions on rest days than on training days,
there were no significant differences between males and
females for any of the total eating frequencies, snack, or
daily meal intakes. Athletes age ≤18 years ate less often
on training days (p = .001), eating both fewer meals (p
= .013) and snacks (p = .005) than their older counterparts.
There were no significant differences between genders or
among age groups for eating frequency on rest compared
with training days.

Nearly all athletes consumed the three daily meals
of breakfast (98.9% ± 7.1%), lunch (97.9% ± 9.2%),
and dinner (98.7% ± 7.5%), as shown in Table 6. The
percentage of athletes who consumed meals on training
day did not differ from the eating frequencies observed
on rest days. Overall, afternoon snacking was more
common than either morning or evening snacks, but
a.m. and p.m. snacks were consumed significantly more
often on training days than rest days (p < .001 and p
< .001, respectively), while evening snacking consumption
was similar.

The contribution of each meal occasion expressed
as a percentage of TEI for all subjects by gender and
age category is shown in Figure 1. Breakfast ranged
from 19.5% to 20.7% of daily energy intake, a.m. snack
5.2–8.2%, lunch 24.6–26.3%, p.m. snack 9.2–12.0%,
dinner 29.5–31.6%, and evening snack 6.2–7.2%. The
only significant difference observed in the meal/snack
analyses by %TEI was that fewer calories were consumed
in the a.m. snacks by the ≤18 age group than by the 19- to
24-year age group, p = .003.

Discussion
This study is the first to examine eating frequencies and
the composition of these eating occasions of Canadian
high-performance athletes. Furthermore, there are few
comparable international studies of this nature (Burke et
al., 2003; Butterworth et al., 1994; Nogueira & DaCosta,
2004) that encompass as many diverse sports and include
both genders. In this study, subjects self-reported their
food and fluid intake over a 3-day period in which they
physically trained at least 2 of the 3 days. An overwhelm-
ing majority ate three daily meals, yet they self-adjusted
their intakes by eating less, primarily with fewer snacks,
and by reducing carbohydrate and protein intakes on rest
versus training days.

As previously reported for these subjects, the dietary
intakes of micronutrients exceeded Recommended Daily
Intakes (RDI) with and without supplements, while their
energy intakes were found to be on average 300 kcal
lower than estimated requirements (Lun et al., 2009). Of
all micronutrients, only the females were found to have
low vitamin D intakes.

Low energy intakes, as seen in this study (females
2,391 ± 719 kcal/day, males 3,055 ± 947 kcal/day) are not
uncommon among athletes (de Sousa et al., 2008; Farajian
Table 2  Comparison of Macronutrient Intakes by Gender, Age, and Training Versus Rest Days, $M \pm SD$

|                          | Gender Age Group, years | Training Versus Rest Day |  |  |  |  |  |  |  |  |
|--------------------------|-------------------------|--------------------------|  |  |  |  |  |  |  |  |
|                          | Total, $N = 324$ | Males, $n = 114$ | Females, $n = 201$ | $\leq 18$, $n = 121$ | 19–24, $n = 103$ | $\geq 25$, $n = 62$ |  |  |  |  |
| Energy, kcal/day         | 2,636 ± 863 | 3,055 ± 947* | 2,391 ± 719* | 2,384 ± 755a | 2,861 ± 1,033b | 2,741 ± 747b | <.001 | 2,781 ± 1,045† | 2,572 ± 1,042† | .002 |
| Fat g/day                | 82 ± 37 | 95 ± 41* | 74 ± 32* | 71 ± 30a | 90 ± 43b | 87 ± 35b | <.001 | 86 ± 45 | 85 ± 49 | .836 |
| g · kg$^{-1}$ · day$^{-1}$ | 1.2 ± 0.5 | 1.3 ± 0.5 | 1.2 ± 0.5 | 1.1 ± 0.5 | 1.3 ± 0.6 | 1.2 ± 0.4 | .241 | 1.3 ± 0.6 | 1.2 ± 0.6 | .702 |
| % TEI                    | 27 ± 6 | 27 ± 6 | 27 ± 6 | 26 ± 5 | 28 ± 6 | 28 ± 7 | .071 | 27 ± 7† | 29 ± 8† | .008 |
| Protein g/day            | 128 ± 47 | 155 ± 54* | 111 ± 33* | 107 ± 34a | 141 ± 51b | 141 ± 51b | <.001 | 137 ± 60† | 124 ± 51† | .002 |
| g · kg$^{-1}$ · day$^{-1}$ | 1.9 ± 0.6 | 2.1 ± 0.7* | 1.8 ± 0.5* | 1.7 ± 0.6a | 2.0 ± 0.6b | 2.0 ± 0.6b | .004 | 2.0 ± 0.7† | 1.8 ± 0.6† | .002 |
| % TEI                    | 20 ± 5 | 20 ± 5* | 19 ± 4* | 18 ± 3a | 20 ± 5b | 21 ± 5b | <.001 | 20 ± 5 | 20 ± 5 | .647 |
| Carbohydrate g/day       | 362 ± 124 | 410 ± 135* | 334 ± 110* | 341 ± 114a | 388 ± 149b | 364 ± 108b,a | .021 | 382 ± 142† | 341 ± 150† | <.001 |
| g · kg$^{-1}$ · day$^{-1}$ | 5.4 ± 1.8 | 5.6 ± 1.8 | 5.3 ± 1.8 | 5.5 ± 1.8 | 5.5 ± 2.0 | 5.1 ± 1.5 | .432 | 5.6 ± 1.9† | 5.0 ± 2.1† | .001 |
| % TEI                    | 55 ± 8 | 54 ± 8* | 56 ± 8* | 57 ± 7a | 54 ± 8b | 53 ± 9b | .001 | 55 ± 9† | 53 ± 11† | .039 |

Note. TEI = total energy intake. Values within age categories with different superscripts are significantly different ($p$ values shown) using 1-way ANOVA with Bonferroni post hoc test to determine differences.

*Significant difference between males and females using independent $t$ tests ($p$ values shown). †Significant difference between training days and rest days using paired-samples test ($p$ values shown).
Table 3  Average Daily Energy Intake and Macronutrient Breakdown for Females (n = 201), M ± SD

<table>
<thead>
<tr>
<th></th>
<th>Breakfast</th>
<th>a.m. snack</th>
<th>Lunch</th>
<th>p.m. snack</th>
<th>Dinner</th>
<th>Evening snack</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>489 ± 226^a</td>
<td>163 ± 209^b</td>
<td>588 ± 203^c</td>
<td>275 ± 227^d</td>
<td>700 ± 238^e</td>
<td>176 ± 189^b</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>19.7 ± 11.2^a</td>
<td>5.5 ± 8.3^b</td>
<td>29.2 ± 12.3^c</td>
<td>10.0 ± 9.9^d</td>
<td>40.5 ± 14.4^e</td>
<td>6.3 ± 7.9^b</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>77.3 ± 35.2^a</td>
<td>26.4 ± 29.9^b</td>
<td>78.1 ± 31.2^c</td>
<td>40.6 ± 30.1^d</td>
<td>85.8 ± 36.6^e</td>
<td>26.1 ± 27.8^b</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>13.0± 9.7^a</td>
<td>4.6± 9.3^b</td>
<td>19.0± 10.0^c</td>
<td>9.1± 11.6^d</td>
<td>22.3± 11.1^e</td>
<td>5.6± 8.2^b</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note. Statistics calculated using general linear-model repeated-measures ANOVA with a Greenhouse-Geisser correction (p values shown) and with Bonferroni post hoc test to determine differences between meals and snacks. Values within a row with different superscripts are significantly different.

Table 4  Average Daily Energy Intake and Macronutrient Breakdown for Males (n = 114), M ± SD

<table>
<thead>
<tr>
<th></th>
<th>Breakfast</th>
<th>a.m. snack</th>
<th>Lunch</th>
<th>p.m. snack</th>
<th>Dinner</th>
<th>Evening snack</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>593 ± 270^a</td>
<td>240 ± 268^bc</td>
<td>784 ± 297^d</td>
<td>319 ± 236^b</td>
<td>900 ± 329^e</td>
<td>218 ± 221^c</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>23.0± 11.5^a</td>
<td>10.8± 13.3^bc</td>
<td>41.3± 18.8^d</td>
<td>14.4± 14.4^b</td>
<td>57.5± 23.3^e</td>
<td>8.0± 10.2^b</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>98.1± 35.2^a</td>
<td>59.5± 39.9^b</td>
<td>78.1± 31.2^c</td>
<td>70.2± 45.8^c</td>
<td>101.3± 46.6^d</td>
<td>26.1± 27.8^b</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>16.1± 11.6^a</td>
<td>8.3± 14.2^b</td>
<td>25.9± 13.0^c</td>
<td>9.4± 8.9^b</td>
<td>28.7± 15.6^c</td>
<td>6.3± 9.0^b</td>
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</table>

Note. Statistics calculated using general linear-model repeated-measures ANOVA with a Greenhouse-Geisser correction (p values shown) and with Bonferroni post hoc test to determine differences between meals and snacks. Values within a row with different superscripts are significantly different.

et al., 2004; Hinton et al., 2004; Juzwiak et al., 2008; Ziegler et al., 2002). However, it has been suggested that most self-reported dietary intakes are underestimated by approximately 20% (Burke, 2001a). A recent study of female and male Canadians age 12–19 years from the general population reported average caloric intakes of 2,047 kcal/day and 2,806 kcal/day, respectively. It has been estimated that older (20–39 years) female Canadians consumed 1,899 kcal/day, and males, 2,660 kcal/day (Statistics Canada, 2004).

Compared with current sport nutrition recommendations (ADA et al., 2009), subjects in the current study were not meeting recommended intakes of carbohydrates relative to body weight (i.e., they consumed <6 g · kg⁻¹ · day⁻¹) yet exceeded athletic requirements for protein. These findings are consistent with other athletic populations (Farajian et al., 2004; Juzwiak et al., 2008, Paschoal & Amancio, 2004), especially females (Burke et al., 2003; Clark et al., 2003; Jonnalagadda et al., 2004; Nogueira & DaCosta, 2004; Petersen et al., 2006). However, specific carbohydrate requirements vary based on the type, volume, and intensity of training undertaken, so individual assessment of carbohydrate intakes relative to requirements would be advantageous.

Gender and Food Patterns

Almost all the athletes consumed three meals and approximately two snacks daily. In this study, males consumed significantly more food energy and grams of fat, protein, and carbohydrate than did females. In relation, both genders consumed their greatest source of food energy in their evening meal and afternoon snack, with the lowest meal energy intake at breakfast. Several studies have observed similar findings with the evening meal (Butterworth et al., 1994; Leblanc et al., 2002; Ziegler et al., 2002), while other investigations (Garcia-Roves, Fernandez, et al., 2000; Nogueira & DaCosta, 2004) have found the midday meal to be the greatest source of food energy. We did not examine the time of day when athletes exercised relative to their meal and snack intake, so assessment of their exercise-recovery nutrition practices could not be undertaken.

Approximately one quarter of the athletes’ TEI (24.3%) came from snacking, regardless of gender, which is consistent with other findings ± 4% in athletic groups (Burke et al., 2003; Butterworth et al., 1994; Nogueira & DaCosta, 2004; Ziegler et al., 2002). Males consumed the least energy in their evening snack, while the smallest snack for females was in the morning. The %TEI derived from snacking in our study was a little lower than what has been observed in the general Canadian population—snacks made up 28–30% of TEI for males and females age 14–18 years and 26–27% of TEI for 19- to 30-year-olds (Statistics Canada, 2004). In comparison, van Erp-Baart et al. (1989) examined the intakes of 419 athletes and determined that 32–37% of their TEI came from snacking.

Leblanc et al. (2002) suggested that athletes divide their TEI meal pattern in a specific manner (i.e., breakfast 25%, lunch 45%, dinner 30%, with all snacks combined <10%), yet to date there is no sport nutrition consensus statement regarding eating occasions or composition of each meal/snack, with the exception of recommendations...
### Table 5  Comparison of Eating-Frequency Patterns by Gender and Age on Training and Rest Days, $M \pm SD$

<table>
<thead>
<tr>
<th></th>
<th>All days</th>
<th>Training days</th>
<th>Rest days</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of eating occasions/day</td>
<td>$4.8 \pm 0.8$</td>
<td>$4.9 \pm 0.8^{*}$</td>
<td>$4.5 \pm 1.0^{*}$</td>
<td>$&lt;.001$</td>
</tr>
<tr>
<td>males</td>
<td>$4.9 \pm 0.8$</td>
<td>$5.0 \pm 0.8$</td>
<td>$4.6 \pm 1.1$</td>
<td></td>
</tr>
<tr>
<td>females</td>
<td>$4.8 \pm 0.7$</td>
<td>$4.9 \pm 0.7$</td>
<td>$4.4 \pm 1.0$</td>
<td></td>
</tr>
<tr>
<td>$p = .420$</td>
<td>$p = .376$</td>
<td>$p = .318$</td>
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</tr>
<tr>
<td>≤18 years</td>
<td>$4.6 \pm 0.8^{a}$</td>
<td>$4.7 \pm 0.8^{a}$</td>
<td>$4.3 \pm 1.0$</td>
<td></td>
</tr>
<tr>
<td>19–24 years</td>
<td>$5.0 \pm 0.7^{b}$</td>
<td>$5.1 \pm 0.7^{b}$</td>
<td>$4.6 \pm 1.1$</td>
<td></td>
</tr>
<tr>
<td>≥25 years</td>
<td>$4.9 \pm 0.8^{b}$</td>
<td>$5.1 \pm 0.8^{b}$</td>
<td>$4.6 \pm 1.0$</td>
<td></td>
</tr>
<tr>
<td>$p = .001$</td>
<td>$p &lt; .001$</td>
<td>$p = .521$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of meals/day</td>
<td>$3.0 \pm 0.1$</td>
<td>$3.0 \pm 0.2$</td>
<td>$2.9 \pm 0.3$</td>
<td>$.078$</td>
</tr>
<tr>
<td>males</td>
<td>$3.0 \pm 0.1$</td>
<td>$3.0 \pm 0.1$</td>
<td>$3.0 \pm 0.1$</td>
<td></td>
</tr>
<tr>
<td>females</td>
<td>$3.0 \pm 0.2$</td>
<td>$3.0 \pm 0.2$</td>
<td>$2.9 \pm 0.3$</td>
<td></td>
</tr>
<tr>
<td>$p = .064$</td>
<td>$p = .201$</td>
<td>$p = .089$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤18 years</td>
<td>$2.9 \pm 0.2^{a}$</td>
<td>$2.9 \pm 0.3^{a}$</td>
<td>$2.9 \pm 0.3$</td>
<td></td>
</tr>
<tr>
<td>19–24 years</td>
<td>$3.0 \pm 0.1^{b}$</td>
<td>$3.0 \pm 0.1^{b}$</td>
<td>$3.0 \pm 0.3$</td>
<td></td>
</tr>
<tr>
<td>≥25 years</td>
<td>$3.0 \pm 0.1^{ab}$</td>
<td>$3.0 \pm 0.1^{b}$</td>
<td>$3.0 \pm 0.2$</td>
<td></td>
</tr>
<tr>
<td>$p = .013$</td>
<td>$p = .004$</td>
<td>$p = .562$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of snacks/day</td>
<td>$1.9 \pm 0.7$</td>
<td>$2.0 \pm 0.7^{*}$</td>
<td>$1.5 \pm 1.0^{*}$</td>
<td>$&lt;.001$</td>
</tr>
<tr>
<td>males</td>
<td>$1.9 \pm 0.8$</td>
<td>$2.0 \pm 0.8$</td>
<td>$1.6 \pm 1.0$</td>
<td></td>
</tr>
<tr>
<td>females</td>
<td>$1.9 \pm 0.7$</td>
<td>$1.9 \pm 0.7$</td>
<td>$1.5 \pm 1.0$</td>
<td></td>
</tr>
<tr>
<td>$p = .649$</td>
<td>$p = .525$</td>
<td>$p = .570$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤18 years</td>
<td>$1.7 \pm 0.7^{a}$</td>
<td>$1.8 \pm 0.8^{a}$</td>
<td>$1.4 \pm 0.9$</td>
<td></td>
</tr>
<tr>
<td>19–24 years</td>
<td>$2.0 \pm 0.7^{b}$</td>
<td>$2.1 \pm 0.7^{b}$</td>
<td>$1.6 \pm 1.1$</td>
<td></td>
</tr>
<tr>
<td>≥25 years</td>
<td>$2.0 \pm 0.8^{ab}$</td>
<td>$2.1 \pm 0.8^{b}$</td>
<td>$1.6 \pm 1.1$</td>
<td></td>
</tr>
<tr>
<td>$p = .005$</td>
<td>$p = .002$</td>
<td>$p = .679$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Out of a possible 6 total eating opportunities each day (3 meals, 3 snacks). Statistics done using 1-way ANOVA with Bonferroni post hoc test to determine differences between age categories and genders. Values within a column with different superscripts are significantly different ($p$ values shown above data). *Values within a row are significantly different for training days vs. rest days ($p$ values shown in separate column).

### Table 6  Percentage of Subjects Who Consumed a Meal or Snack Over 3 Days, $M \pm SD$

<table>
<thead>
<tr>
<th>Meal/Snack</th>
<th>Total ($N = 324$)</th>
<th>Training days</th>
<th>Rest days</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>$98.9% \pm 7.1%$</td>
<td>$99.3% \pm 5.9%$</td>
<td>$98.2% \pm 12.6%$</td>
<td>$.102$</td>
</tr>
<tr>
<td>a.m. snack</td>
<td>$57.3% \pm 36.2%$</td>
<td>$62.0% \pm 39.0%^{*}$</td>
<td>$38.0% \pm 47.4%^{*}$</td>
<td>$&lt;.001$</td>
</tr>
<tr>
<td>Lunch</td>
<td>$97.9% \pm 9.2%$</td>
<td>$98.1% \pm 9.4%$</td>
<td>$97.8% \pm 14.6%$</td>
<td>$.276$</td>
</tr>
<tr>
<td>p.m. snack</td>
<td>$71.6% \pm 32.0%$</td>
<td>$74.4% \pm 33.6%^{*}$</td>
<td>$63.1% \pm 47.5%^{*}$</td>
<td>$&lt;.001$</td>
</tr>
<tr>
<td>Dinner</td>
<td>$98.7% \pm 7.5%$</td>
<td>$98.9% \pm 9.0%$</td>
<td>$97.8% \pm 14.6%$</td>
<td>$.317$</td>
</tr>
<tr>
<td>Evening snack</td>
<td>$58.1% \pm 36.1%$</td>
<td>$58.8% \pm 39.0%$</td>
<td>$53.2% \pm 49.3%$</td>
<td>$.667$</td>
</tr>
</tbody>
</table>

**Note.** Average of 3-day frequency of meals/snacks consumed.

*Statistical difference between training and rest days for a given meal occasion ($p$ values shown) using Wilcoxon signed-rank test.
for pre- and postexercise nutrition (ADA et al., 2009; Burke, 2001a; Burke & Deakin, 2010; Hawley & Burke, 1997; Houtkooper et al., 2007; Ivy, 2001; Jentjens & Jeukendrup, 2003, Kerksick et al., 2008; Ziegler et al., 2002). In this current study the overall amount of energy derived from snacks was ~641 kcal/day, with males consuming more energy-dense snacks than females did.

Variations by Age

Athletes younger than 19 consumed the least total energy (yet they are physiologically maturing), ate less often (especially the morning snack), and consumed less fat and protein but were found to have higher carbohydrate intakes based on %TEI. It is possible that young athletes are least likely to exercise in the morning and therefore may not eat as much during the day when they are in school. Conversely, compared with the youngest age group, the 19- to 24-year-old athletes had a higher energy intake in their morning snack, potentially as part of their recovery nutrition. In comparison, Americans in the general population have been shown to consume snacks with 472 and 496 kcal/day for those >19 years old and 2- to 18-year-olds, respectively (Popkin & Duffey, 2010), which is substantially fewer calories than observed in this current study (i.e., 585–730 kcal/day).

Training Versus Rest Days

In the current study, subjects self-adjusted their eating frequencies on training days, in that they ate approximately half a snack more than on rest days, though there were no differences with reported meal frequencies on rest versus training days. These findings were consistent regardless of gender or age. Primarily the morning snack was omitted on inactive days. The athletes also reduced their reported energy intake on their rest days compared with their training days, primarily by reducing their protein and carbohydrate consumption. These findings are in contrast to those of Vogt et al. (2005), who found no differences in the energy intake of professional cyclists between rest and training days during a 6-day training camp.

Limitations

This study did not examine the time of day when subjects trained, nor was the number of training sessions per day assessed. This additional information may be helpful to evaluate athletes’ intakes before and after exercise. Self-reported dietary intakes have their limitations but are practical when acquiring data from a large number of subjects across multiple national centers. Inclusion of comparable, nonathletic control subjects may have resulted in additional unique observations. Furthermore, information on whether athletes, particularly those <18 years of age, were living independently was not collected.
but could potentially have influenced the composition and frequency of meals.

**Practical Application**

This study demonstrates that the majority of elite Canadian athletes in this study ate often and consumed more energy on training versus rest days, which could be in part related to their body composition and the thermic effect of exercise, as well as their energy and nutrient requirements (ADA et al., 2009; Burke, 2001a; Burke & Deakin, 2010; Gatenby, 1997; Hawley & Burke, 1997; Rosenbloom, 2000). Almost all subjects consumed three meals daily and self-adjusted their diet on rest days. Younger athletes need to be encouraged to eat often and include energy-dense snacks, especially in the morning. High-performance athletes need to be educated about their physiological requirements for carbohydrates with practical meal and snack suggestions to support their individual energy needs relative to their training (i.e., exercise volume, frequency, and intensity). Knowledge of athletes’ eating patterns is essential to effectively advise them about their dietary intake, especially in regard to their pre- and postexercise nutrition. This study may help establish eating-pattern guidelines and recommendations for athletic populations. Those doing subsequent research may want to investigate the justification for snacking among athletes, aside from hunger.

**Acknowledgments**

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**References**


