International Journal of Science Culture and Sport
June 2016 : 4(2)
ISSN : 2148-1148
Doi : 10.14486/IntJSCS518

***Field** : Sport Sciences, Physiology*
***Type** : Research Article*
***Recieved:** 26.04.2016 – **Accepted:** 11.06.2016*

Differences among Elite Female Rowers Regarding Carbohydrate Consumption at Rest

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Abstract

Backround: The objective of this study was interpreting the reported differences within carbohydrate consumption at rest, in female rowing groups.

Method: We conducted a cross-sectional study, on a group of elite rowing athletes, monitoring carbohydrate consumption at rest. 34 subjects, divided in 3 groups of activities (senior, youth, junior) took part in this study being monitored through Cosmed Quark CPET device.

Results: The average amount of carbohydrates consumed at rest among the group of seniors was 263.6 grams/day, representing 1080.76 kcal. Youth group has reached an average of 248 grams/day, representing 1016.8 kcal., whereas the junior group has reached high average consumption of carbohydrates, 359 grams/day, equivalent to 1417.9 kcal/day. Noticeable differences among the average value was recorded between G3-G1, G3-G2 groups while the most significant differences were seen between G1-G3, and G2-G3 groups of athletes.

Conclusion: The results of this study show a lack of adaptation among athletes in exercise performed with a monitored increased carbohydrate consumption at rest, and a low lipid consumption. At the same time, increased preponderance of carbohydrates at rest can negatively affect the activity of recovery, in terms of energy and nutritional needs by initiating the specific effort with an advanced stage of fatigue dictated by time spent in anaerobic effort indicated by the energy consumption of the monitored athletes.

Keywords: Carbohydrate; Macronutrients; Recovery; Rowers

Introduction

Energy requirements represent the total amount of energy that the body needs to maintain vital functions, optimal body function, and to maintain a balance body weight (Thompson, 1998:160-174). For any individual, energy consumption is influenced by three factors: basal metabolism - the minimum amount of energy that the body needs; physical activity - voluntary (represented by programmed physical actions); physical activity - involuntary (unscheduled physical activity that is not able to represent a form of training); thermogenesis - induced stimuli (shown in individual activity, stress and psychological feelings); thermogenesis - induced by external stimulus (represented by the environment) (Betts et al. 2014:539–547; Valente et al. 2015:262-273; Francesco Celi et al. 2015:238-247; Sakamoto et al. 2014:e533-539).All these factors will influence the energy requirements. Individually, energy metabolism through the main energy sources distribution can indicate the energy efficiency of the body(Pörtner et al. 1996:1403-1414). As a result, in optimal conditions, the carbohydrate substrate in the case of female groups, will represent a secondary energy source at rest, in the detriment of fat metabolism (Tarnopolsky, 2003:39-46). Female athletes benefit from a relatively low consumption of carbohydrate during a specific exercise (Hardman,1999:369-76; Sousa et al. 2015:2095-2546). However, the practice itself can prolong the total time in activity, depending on the specificity of the activity performed and the effort zone (Wismann et al., 2006:28-34).

Moreover, the lipid energy sources have a high rate of use during exercise for the female groups, unlike male group of activity (Neethling et al., 2014:599-606; Horton et al., 1998:1823-1832). The increased level of lipid oxidation in both groups was reported at a medium intensity which is characterized within the aerobic zone of exercise (Achten et al. 2003:747–752; Brun et al., 2011:57-71; Alessio et al., 1998:123; Coquart et al., 2011:32-37) Which does not induce the body into a anaerobic zone of effort, associated with carbohydrate as the main source of energy due to oxygen content (Martin et al., 2015:247). Increased consumption of carbohydrates at rest, over 55-60% of the total value may indicate a lack of energy system efficiency, culminated by increased total recovery time in the activity groups. Unlike the carbohydrates and lipids, the protein substrate will be used as energy source only in limited cases in which the main energy substrate, the carbohydrate, has been used by the body. The amount of energy stored in the form of fat is large, representing 92–98% of all endogenously stored energy with CHO contributing only about 2–8% (Melzer, 2011:45–52).

The lack of glucose in the body results in the consumption of proteins to supply the nervous system (Poortmans, 2012:875-890). Action which is frequently associated with the state of catabolism, degradation of muscle mass and weight loss (Bilsborough et al., 2006:129-152).

Methods

We conducted a cross-sectional study, on a group of elite rowing athletes. Monitoring and data extraction was performed by using Cosmed Quark CPET equipment obtaining the following data: body mass index (BMI), the maximum amount of oxygen (VO2max), resting energy expenditure (RMR), carbohydrate consumption at rest (Ccarbohydrates), lipid consumption at rest (Clipid). The research group was consisted of 34 subjects divided in three groups based on the particular age and level of training performed, as it follows: the first group (G1) 11 seniors with age X ± SD = 22.82 ± 3.371, the second group (G2) including eight youth athletes, age ± SD = 20.25 ± 1165, and the third group (G3) consists of 15 junior athletes, age± SD = 16.80 ± 3.601.

The tests were conducted in June-July, 2015, following the next protocol: lack of food ingestion within 5 hours before the test; lack of sport activity within 24 hours before the test; the absence of caffeine intake for at least 12 hours prior testing; lack of sports supplements consumption containing: ephedrine, Ma Huang, pseudoephedrine with 12 hours before testing; the absence of nicotine within 12 hours before testing.

The data were processed using the GraphPad Prism 5 software. The statistical indicators targeted were: arithmetic mean (X), standard deviation (SD), standard error (SE), minimum and maximum coefficient of variation (CV), Shapiro-Wilk (W) test for data normalization $\alpha = 0.05$, Pearson correlation index (r), and student t-test (paired). Significance level, $p<0.05$ was considered statistically significant for research. All athletes participating in the research have given informal approval to process existing data.

Results

The results presented further highlights the quantitative values of energy metabolism based on the level of activity and its specificity. The data illustration took into account the connection established between the parameters analyzed for each group of activity based on the information obtained (Table 1, Table 2, Table 3, Table 4).

Table 1. Descriptive statistics for the senior group (G1)

Statistical index	Height	Weight	BMI	VO_{2max}	RMR	$C_{carbohydrates}$	C_{lipids}
Minimum	176.0	58.20	18.16	253.0	1782	136.9	13.54
Maximum	186.0	82.50	24.00	319.0	2304	521.0	156.5
Mean (X)	181.9	71.85	21.62	292.5	2059	300.6	85.83
SD	3.673	7.973	1.818	21.42	170.3	124.8	45.32
CV	2.01%	11.09%	8.40%	7.32%	8.27%	41.51%	52.8%
SE	1.107	2.404	0.5482	6.459	51.35	37.64	13.66
Shapiro-Wilk - W	0.892	0.925	0.891	0.924	0.949	0.950	0.952
Passed normality test?∗	Yes	Yes	Yes	Yes	Yes	Yes	Yes
t, df (10)	t=164.3	t=29.89	t=39.44	t=45.29	t=40.09	t=7.986	t=6.281
P value (two tailed)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Significant? ∗	Yes	Yes	Yes	Yes	Yes	Yes	Yes

∗p<0.05

Table 2. Descriptive statistics for the youth group (G1)

Statistical index	Height	Weight	BMI	VO_{2max}	RMR	$C_{carbohydrates}$	C_{lipids}
Minimum	177.5	59.20	18.80	259.0	1768	93.00	92.20
Maximum	182.0	75.00	23.00	324.7	2253	287.6	147.6
Mean (X)	180.1	70.78	21.78	294.6	2028	229.7	116.2
SD	1.568	4.998	1.359	22.57	163.0	59.44	18.42
CV	0.87%	7.06%	6.23%	7.66	8.03%	25.87%	15.85%
SE	0.5545	1.767	0.4806	7.978	57.64	21.02	6.513
Shapiro-Wilk - W	0.939	0.744	0.820	0.959	0.979	0.773	0.964
Passed normality test? *	Yes	No	No	Yes	Yes	No	Yes
t, df (7)	t=324.7	t=40.06	t=45.31	t=36.92	t=35.18	t=10.93	t=17.85
P value (two tailed)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Significant? *	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*$p<0.05$

Table 3. Descriptive statistics for the junior group (G1)

Statistical index	Height	Weight	BMI	VO_{2max}	RMR	$C_{carbohydrates}$	C_{lipids}
Minimum	174.0	65.00	19.60	256.0	1839	195.9	32.70
Maximum	186.0	85.00	25.50	318.0	2249	423.6	121.3
Mean (X)	180.6	72.87	22.35	287.2	2029	333.1	68.54
SD	3.601	4.769	1.685	16.82	111.4	64.15	25.19
CV	1.99%	6.54%	7.53%	5.85%	5.49%	19.25%	36.75%
SE	0.9298	1.231	0.4350	4.343	28.77	16.56	6.504
Shapiro-Wilk (W)	0.952	0.923	0.965	0.976	0.958	0.926	0.929
Passed normality test? *	Yes	Yes	Yes	Yes	Yes	Yes	Yes
t, df (14)	t=194.2	t=59.18	t=51.37	t=66.13	t=70.52	t=20.11	t=10.54
P value (two tailed)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Significant? *	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*$p<0.05$

Table 4. The correlation between energy, somatic, and effort parameters (G1-G2-G3)

	Statistical index – paired	r	Sig. r
G1	VO_{2max} & BMI	.728	.011
	VO_{2max} & RMR	.977	.000
	$C_{carbohydrates}$ & C_{lipids}	-.956	.000
G2	VO_{2max} & BMI	.454	.259
	VO_{2max} & RMR	-.289	.488
	$C_{carbohydrates}$ & C_{lipids}	-.757	.030
G3	VO_{2max} & BMI	.381	.161
	VO_{2max} & RMR	-.524	.045
	$C_{carbohydrates}$ & C_{lipids}	-.899	.000

The values registered for t_{value} parameter, for all groups count variables are superior to the values of $t_{critical}$ parameter, and p_{values} were <0.0001. Shapiro-Wilk test values reflect significante normality for α=0.05.

The variability coefficient for the parameters analyzed show a very good homogeneity for the research groups. The values obtained fall in proportion of 71.42%, between the range of 0-15%, resulting a very good homogeneity of the group data identified within studied parameters (G1, G2, G3), excluding the information whitch include carbohydrate, and lipid consumption at rest (Table 1, Table 2, Table 3). A good homogeneity (15-30%) has been identified in the carbohydrate/ lipids consumption level at rest, in the G2, G3 groups (carbohydrates consumption), while heterogeneity (>35%) was found in G1, regarding macronutrients consumption at rest.

Energy metabolism data monitored has shown a statistically significant correlation between carbohydrate consumption at rest and fat consumption in the same situations in all the groups included in the study (p = 0.0001), although Pearson index for G1 was -.956, but *t* value was 4.222; for G2, *r* index was -.757 and *t* has reached a value of 4.314; For G3 *r* value was -.899, *t* was set at 11.712; All *t* values reported were higher than the recorded t_{tabel} values, the differences being statistically significant (Tabel 4).

The value regarding body mass index in the group of seniors has reached an average of 21, 8. In the case of youth group, the average BMI does not exceed 21.85, however the most increased value was reported among the juniors group, at an average value 22, 2. BMI differences between G1 and G2 was 0.16 (G2), differences between G2 and G3 has reached a value of 0.57, and between G1 and G3, we obtained a difference of 0.73. VO_{2max} results, individually, for each group was determined as it follows: mean value for seniors - 293 ml / min; mean value for youth - 300.1 ml / min; mean value for juniors - 282 mL / min. As a result, the difference between G1 and G2 values were 2.1 ml / min (G2), between G2 and G3 of 7.4 ml / min, and the difference between G1 and G3 has reached a value of 5.3 ml / min.

Carbohydrate intake, primary aspect discussed, varied based on work performed by each activity group in part (sports training periodization is different for each activity group). The average amount of carbohydrate consumption at rest in the seniors group of activity has reached a value of 263.6 grams/ day, equal to 1080.76 kcal. The youth activity group has reached an average of 248 grams/ day, representing 1016.8 kcal. The junior group of activity has reached the highest average carbohydrate consumption value equal to 359 grams / day, representing 1417.9 kcal / day (Fig.1).

Wide variations of mean values determined were recorded between G1 and G3 group (30.5 gr. - G3), G2 and G3 (103.4 gr - G3) as well as being identified significant statistically values between groups G2-G3 (p = 0.003).

The percentage that lipids represent as a main energy source during low level activity/ rest, is limited in all the groups represented. Thus, in the group of seniors, the average value obtained was 79.60 grams / day, representing an average of 724 kcal / day. In the youth group we identified an average of 115.9 grams / day, equivalent to 1054.69 kcal / day, while the group of juniors reported the lowest level of fat consumption, 66.66 grams / day, and equivalent to 606.60 kcal / day (Fig. 1).

The most important differences were seen between G1 - G3 (17.3 gr.) groups, G2 and G3 (47.66 gr.) groups. Statistical significance values were obtained between G2 and G3 groups (p = 0.007).

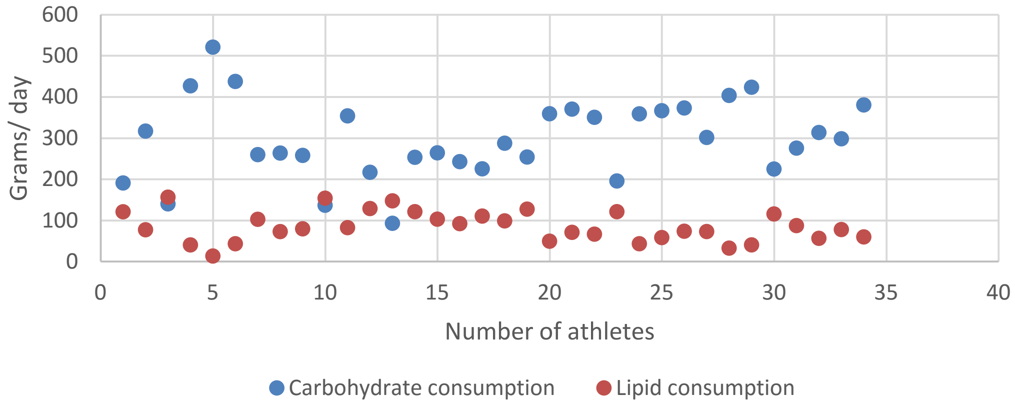

Fig. 1. Carbohydrate/ fat consumption at rest in the activity groups (G1-G2-G3)

The amounts of macronutrients used during recovery period, are associated with an average energy consumption at rest, for the existing groups, of 2046 kcal. The differences found between the studied groups were as it follows: 12 kcal between G1 - G2; 27 kcal between G1-G3; 27 kcal between G2-G3; representing insignificant statistically data between the resting energy expenditure despite we have analyzed three different age and activity groups of athletes.

Discussions

A scientific based sport of performance is essentially and major conditioned by the biological adaptation degree of the body to obtain sportive performance. Sportive training is defined as a multilateral, complex, psycho-social, methodical and pedagogical process, which monitors the morphological-functional perfection of the body, with the purpose to increase the sanogenetic standard, the resistance to exogenous and endogenous factors and to improve the psycho-physical effort capacity, all these summed up leading to high sportive performance (Badau et al., 2010:372-375; Herzog 2012:4; Popescu, 2010:869-874; Badau D. 2014:24-28). Given the changes that may be dictated by the nature of sport (sometimes with an adverse health impact), or the "imposed" practices to reach a high level of performance, the importance of nutrition and its role in training become of outmost importance (Martin et al., 2015:241–246; Hawley et al., 2014:738-749; Šatalić 2016:118-123; Labarde, 2015:49-52; Laurenson et al. 2014:1-5).

The actual activity time spent during a 2.000 m course, ranges between 6 and 8 minutes depending on the specific activity performed. Energy consumption for such activity ranges between 200 and 250 kcal. In contrast, energy expenditure report for a period of 1-2 hours of daily training lies between 1000-2000 kcal for the female groups, while the resting energy expenditure is estimated to range between 1800-2500 kcal in the male groups (Hill, 2002:1823-9).The difference is determined by the distribution of macronutrient, and the consumption of the body within the period of rest / recovery, during a period that lasts 12/24 hours post intensity exercise (anaerobe lactacid effort).

The intensity of the effort will be the main factor influencing the energy source used in an increased amount by the body. When exercise intensity increases, carbohydrate consumption is directly proportional (Van Loon et al., 2001:295-304, Hawley et al., 2014:738-49). However, factors such as age, level of training, gender, nutritional status and hormonal status will distinguish the use of energy substrate (Burke, 2001:202-19; Lanfranco et al., 2011:1202;

Laurenson et al. 2014:1-5). Differences in energy substrate use, between the male and female groups were not observed in infancy, through the literature, until the beginning of adolescence. Cataloged as being a period which can provide a macronutrient balance among the distribution of food consumption and consequently an increase in the consumption of carbohydrates at rest (Isacco et al., 2012:327-29; Ruddy, 2014:272-78). This action can be explained by the impact that sex hormones have on energy substrate utilization, transport, use and oxidation during rest or effort periods (Aucouturier et al., 2008:213-38; Djelic et al., 2015:321-27). In contrast to the activity of male groups, a number of authors have described in the female groups an increased lipid oxidation in detriment of carbohydrates during an effort exceeding 50% of VO_2 monitored value (Pillard, 2007:2256-62). In these studies, increased levels of sex steroid hormones have resulted in an improved lipid oxidation and a reduction in carbohydrate oxidation during effort (Hagerman, 1994:221; Tarnopolsky, 2000:312-27; De Bandt et al., 1998:161-86). In fact, puberty can be described as a critical period where due to hormonal changes, energy substrate oxidation will change (Lanfranco et al., 2011:1202; Casazza et al., 2004:302-9; Sanchez-Garrido et al., 2013:187-194).

All the data are reported on a training program which maintain and provide optimal training condition for the athletes in 5 different effort areas (Zone 1, Zone 2, Zone 3, Zone 4, Zone 5 - alactacid anaerobic, anaerobic lactacid, and aerobe effort) suggesting that the total time spent within aerobic effort is reduced. Increasing simple carbohydrate intake, during rest periods, can induce an increase energy consumption in rest, dictated by the food source which is consumed in a high quantity (Hawley et al., 2014:738-49; Wismann et al., 2006:28-34).

Conclusions

Adapting young athletes, in terms of energy needs, within the exercise performed is done in a gradual mode based on the total effort performed. Balancing the intake of carbohydrates with a high preponderance of complex sources, will provide the correct form to meet the carbohydrates need based on the effort performed. On the other hand, youth/ seniors groups, through a constant effort in the anaerobic activity zone, will report a high carbohydrate consumption at rest, associated with a decreased efficiency of the recovery process and a possible metabolic acidosis confirmed biochemically. Imposing a nonspecific effort without having control over the work performed based on a range of cardiac values, indicative of effort performed, has the ability to negatively influence the work done and the main objective of sports training. Therefore the aspect discussed is visible through the results obtained in the group of juniors, the effort provided and research results reveal a significant metabolic and physical load.

Conflict of Interest

The authors have not declared any conflicts of interest.

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