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Research article

Pre-workout carbohydrate supplementation does not affect measures of self-assessed vitality and affect in college swimmers

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Abstract
Beneficial effects of dietary carbohydrate (CHO) on physical and psychological parameters have been demonstrated in athletes. Because affect, or mood, can predict athletic performace, the main objective of this study was to determine the effect of pre-workout CHO on affect in swimmers. College swimmers (n = 37) participated in a randomized crossover experiment of the effects of a pre-workout CHO supplement on vitality and affect. Subjects consumed a CHO supplement or placebo for two days before morning practice. After each morning practice, swimmers completed measures of affect and feelings of vitality. Pearson correlations were performed to describe relationships among variables. Differences in means between the CHO and placebo conditions were determined by paired t-tests. Independent t-tests were used to determine differences in variables between the highest and lowest tertiles of breakfast consumption frequency. All statistical analyses were performed using SAS 9.1.3 (Cary, NC) and statistical signficance was set at $\alpha = 0.05$. There were no significant differences in affect or feelings of vitality between the CHO supplement and placebo conditions (all $p \geq 0.15$). Our results do not support a beneficial effect of CHO supplementation before morning swim practice on affect or feelings of vitality in swimmers.

Key words: Nutrition, swimmers, mood.

Introduction

Mood disturbances have been shown to occur in swimmers during intense training (Morgan et al., 1988; Raglin, 2001) and the Mental Health Model of sport performance (Raglin, 2001) shows that common measures of psychological and mood states identify successful and unsuccessful athletes. In addition to beneficial effects on physiological outcomes (Coggan and Coyle, 1991; Costill et al., 1988), studies have also shown beneficial effects of CHO on psychological factors and cognitive functions and performance (Lieberman, 2003). CHO administration before exercise has been shown to improve vigor and cognitive performance, and reduce confusion compared to placebo during exercise (Lieberman et al., 2002). Drinking CHO solution during prolonged exercise in male cyclists enhanced feelings of pleasure compared to a water placebo (Backhouse et al., 2005). Another study in male endurance runners showed that a high CHO diet not only improved mood, but also exercise performance compared to a lower CHO diet (Achten et al., 2004).

Early morning training sessions are common among swimmers, and often swimmers will forgo eating before these practices (Berning, 2002). Encouraging breakfast consumption may be an opportunity to improve nutrition for swimmers. Inclusion of pre-exercise breakfast may provide a possible avenue to alleviate, diminish, or avoid detrimental mood disturbances that occur with intensive training and increased training volume. In this study, we investigated if dietary intake and breakfast habits are associated with vitality and athlete burnout in swimmers. We also tested the hypothesis that a CHO supplement before morning swim practice would have beneficial effects on vitality and affect in swimmers in a field-based experiment.

Methods

Subjects

Thirty-eight NCAA Division II men and women intercollegiate swimmers volunteered to participate in this study during a period of intensive training. Men and women swimmers trained together in one of three training groups: sprint, mid-distance, and distance. Average practice length was 90 minutes. The sprint group swam an average of 4400 yards/morning practice which consisted of three EN1 (minimum endurance pace) sets and one SP4 (spring level 4) set or one EN1, one EN2 (threshold endurance pace), and one SP4 set. The mid-distance group swam an average of 4800 yards/morning practice which consisted of three EN1 sets and one SP3 (sprint level 3) set or one EN1, one EN2, and one SP3 set. The distance group swam an average of 5400 yards/morning practice which consisted of three EN1 sets or one EN1 and one EN2 set. The swimmers did not change training groups during the course of the study, and practices were similar between the two weeks of the study.

Measures

Vitality, athletic burnout, and affect measures

Feelings of vitality were measured using the 6-item Vitality Scale which uses a 7-point Likert scale ranging from "*not at all true*" to "*somewhat true*" to "*very true*"(Bostic et al., 2000). Athlete burnout was measured using the Athlete Burnout Questionnaire (ABQ), which was originally developed and validated with swimmers (Raedeke and Smith, 2001). The questionnaire has 15-items to measure three subscales of athlete burnout: *reduced sense of accomplishment*, *emotional/physical exhaustion*, and *devaluation* using a 4-point Likert scale. Affect was measured using the Activation-Deactivation Adjective Check List (AD ACL), developed and validated by

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Thayer (1989), which measures various transitory states of arousal for four subcategories: *energetic*, *tiredness*, *tension*, and *calmness* on a 20-item, 5-point Likert scale (Thayer, 1989).

Dietary information

Dietary information was collected once at baseline prior to study interventions to describe normal dietary habits. A written, one-day 24-hour dietary recall was completed by each subject. Each dietary recall was reviewed by a registered dietitian or dietetics student under the supervision of a registered dietitian for clarification with each individual subject. Three-dimensional food models and measuring utensils were used to aid in this process. Diet Analysis Plus Version 5.0 for Windows® (Copyright 2001, Wadsworth Group and ESHA Research) was used to analyze the nutrient content from the 24-hour-dietary-recall. Subjects were also asked 10 written questions regarding certain nutrition habits, such as: "How many days per week do you eat or drink something (other than water) before morning swim practice?". For the purposes of this study, we defined 'breakfast' as any caloric food or beverage consumed before morning swim practice.

Anthropometrics

Weight (kg) and height (cm) were measured using a calibrated balance scale and stadiometer (Detecto®, Webb City, MO). Body mass index (BMI) (kg/m^2) was calculated from these measurements.

Procedure

This study was conducted at the home training facility of the swim team. Subjects were instructed to continue their normal eating habits and to be consistent throughout the course of the study. This instruction was to reduce the effects that changes in routine may have on the subjective measures of the study or the upcoming championship competition, and to reduce the burden on the subjects. Approval to conduct this study was granted by the University of North Dakota Institutional Review Board, and all subjects gave informed consent prior to participation.

Height, weight, 24-hour dietary recall, ABQ, and general vitality scale were obtained before a regularly scheduled Saturday morning swim practice (approximately 8AM). The swimmers were randomly assigned into two groups in a double-blind fashion to receive a CHO supplement or placebo before morning swim practice for two (week) days each in a cross-over design. A five-day washout period separated the cross-over conditions. The CHO supplement was 10 fluid ounces of commercially-available strawberry gelatin, which contained 45 g CHO (as sucrose), 5 g protein, and 200 total kcal. The placebo was 10 fluid ounces of commercially-available sugar-free strawberry-flavored gelatin (sweetened with aspartame and acesulfame potassium), which contained 4 g CHO, 2.5 g protein, and 25 total kcal. Subjects were not aware of the placebo condition until the completion of the study to minimize the possibility of detecting the slight taste variation due to the artificial sweetener in the placebo.

Subjects swam their swim practices as normal during the study. Within five minutes following each of the two morning practice sessions each week, the subjects completed the current feelings of vitality scale and the AD ACL.

Statistical analysis

Pearson correlations were used to analyze the relationship between total kcal, total CHO, kcal/kg body weight and CHO/kg body weight from the 24-hour dietary recalls and general vitality scores and the three subscales of the ABQ. Independent t-tests were used to compare general vitality and each subscale of the ABQ between subjects in the highest and lowest tertile for breakfast consumption frequency. Paired t-tests were used to compare the differences between the supplement and placebo conditions on current feelings of vitality and affect (2-day average). All analyses were performed using Statistical Analysis Software (SAS 9.1.3, Cary, NC) and statistical significance was set at $p = 0.05$.

Results

Height, weight, 24-hour dietary recall, and ABQ, and general vitality scale were completed by 37 swimmers, and 34 swimmers completed at least one day on each placebo and CHO supplement in the cross-over study. Subject characteristics and dietary intakes from 24h dietary recalls are shown in Table 1. One swimmer who volunteered for the study missed all components of the study. Total kcal/d was negatively correlated with the *reduced sense of accomplishment* subscale of the ABQ ($r = -0.35$, $p < 0.05$). There were no additional significant correlations between kcal or CHO intake and the ABQ or general vitality (all $p \geq 0.10$). Forty-six percent ($n = 17$) of subjects reported never eating breakfast before morning swim practice. Subjects in the top tertile for breakfast frequency (≥ 3 d/week, $n = 14$) had a higher mean score for the *devaluation* subscale of the ABQ compared to subjects in the bottom tertile (0 d/week, $n = 17$) (3.31 ± 0.90 vs. 2.39 ± 0.92, respectively, $p < 0.01$).

Swimmers reported varied reasons for forgoing breakfast in response to the question, "If you don't eat before morning swim practice, what are the reasons?" The responses followed several main themes and were therefore classified into one of five categories: 'Avoidance of feeling nauseous/ill' ($f = 13$), 'Lack of time' ($f = 12$), 'Lack of access to food' ($f = 7$), 'Don't like it/don't feel like it' ($f = 6$), and 'Lack of hunger' ($f = 5$).

There were no significant effects of the CHO supplement on vitality ($p = 0.22$) or the four subscales (energetic, tiredness, tension, and calmness) of the AD ACL (all $p \geq 0.15$) (Table 2). Sixteen subjects consumed food prior to testing that was not part of the study protocol at least one morning of the study. Therefore, per-protocol analyses were also conducted with these subjects excluded, but results were similar to the original analysis.

Discussion

The objectives of this study were to determine if relationships exist between breakfast and dietary habits and athlete burnout and vitality in swimmers, and to determine if CHO supplementation before morning practice would

Table 1. Subject characteristics and dietary intakes from 24h dietary recalls.

	Men (n = 15)		Women (n = 22)	
	(Freshman, Sophomore, Junior, Senior)			
College Class, n	7, 4, 1, 3		7, 6, 3, 6	
	(Sprint, Mid-Distance, Distance)			
Training Group, n	9, 5, 1		6, 12, 4	
	Mean (±SD)	Min – Max	Mean (±SD)	Min – Max
Age, y	19.6 (1.6)	18 – 23	20.0 (1.4)	18 – 22
Height, m	1.83 (.06) [a]	1.75 – 196	1.69 (.06)	157.5 – 182.9
Weight, kg	78.2 (9.2) [b]	69.1 – 98.6	66.8 (7.1)	53.2 – 76.4
BMI, kg·m^{-2}	23.3 (1.8)	20.1 – 27.2	23.2 (1.9)	20.4 – 28.0
Energy intake				
kcal·d^{-1}	3198 (720) [c]	1851 – 4348	2533 (463)	1525 – 4323
kcal·kg^{-1}per day	41.5 (10.5)	23.8 – 57.9	38.8 (14.5)	20.8 – 81.3
% of daily energy needs	92.3 (21.8)	54.0 – 124.0	92.0 (31.4)	53.0 – 183.0
Carbohydrate intake				
g·d^{-1}	387 (106)	215 – 554	365 (99)	208 – 548
g·kg^{-1} per day	5.1 (1.6)	2.2 – 7.7	5.6 (1.8)	3.2 – 10.1
Protein Intake				
g·d^{-1}	137 (47) [c]	78 – 220	94 (34)	41 – 158
g·kg^{-1} per day	1.8 (.6)	.9 – 2.9	1.4 (.6)	0.6 – 2.9

Difference between sexes: [a] $p < 0.0001$, [b] $p < 0.001$, [c] $p < 0.01$

have a beneficial effect on post-practice subjective measures of affect and feelings of vitality. Previous research (Backhouse et al., 2005) has shown that CHO supplementation in athletes during exercise has positive effects on affect in a laboratory setting. This study investigated if similar results could be found in a field-based study with swimmers.

We found a modest inverse relationship between total daily kcal and the *reduced sense of accomplishment* dimension of athlete burnout which may suggest that better nourished swimmers have less *reduced sense of accomplishment*. Conversely, it was unexpected that swimmers in the top tertile for breakfast consumption who ate breakfast most often had more sport *devaluation* compared to swimmers in the bottom tertile who never ate before swim practice. We propose one possible hypothesis based on the qualitative data collected. The most frequent response for why the swimmers did not eat breakfast before morning swim practice was 'avoidance of feeling nauseous/ill'. Perhaps some swimmers with increased devaluation of the sport train less intensely and do not experience discomfort related to eating prior to practice, or don't care if they experience discomfort. Indeed, fewer swimmers in the top tertile for breakfast consumption frequency reported 'avoidance of feeling nauseous/ill' (14 %) versus swimmers in the bottom tertile (53 %). It seems likely, however, that a complex array of factors is responsible for any associations between diet and athlete burnout. To our knowledge, this is the first exploration of diet and athlete burnout. Prospective studies of athlete burnout in swimmers using more rigorous dietary intake assessment methods would be useful in further establishing if relationships between diet and athlete burnout exist. Additionally, measuring athletic performance along with diet and athlete burnout would be valuable in assessing the importance these factors to athletic success.

The reasons why swimmers reported not eating breakfast before morning practice may be useful to coaches, trainers, or sports nutritionists working with swimmers. Although our study showed no benefit of CHO supplementation on affect or vitality in our study,

Table 2. Descriptive statistics for study variables and differences between means on supplement and placebo conditions.

N = 37		Mean (±SD)	Min – Max	p-value
General Vitality [a]		4.50 (1.19)	1.00 – 6.83	
Reduced Sense of Accomplishment [b]		2.49 (.73)	1.00 – 3.60	
Emotional/Physical Exhaustion [b]		3.25 (.79)	1.20 – 4.80	
Devaluation [b]		2.79 (.97)	1.00 – 4.60	
N = 34				
Current Vitality [a]	**Supplement**	4.21 (1.07)	1.42 – 6.83	.22
	Placebo	3.99 (.83)	2.25 – 6.00	
Energetic [c]	**Supplement**	2.38 (.61)	1.00 – 3.60	.42
	Placebo	2.31 (.59)	1.20 – 4.00	
Tiredness [c]	**Supplement**	2.27 (.71)	1.00 – 3.7 0	.15
	Placebo	2.45 (.66)	1.20 – 4.00	
Tension [c]	**Supplement**	1.64 (.48)	1.00 – 2.70	.72
	Placebo	1.62 (.44)	1.00 – 2.50	
Calmness [c]	**Supplement**	2.32 (.52)	1.40 – 3.60	.19
	Placebo	2.44 (.54)	1.10 – 3.50	

[a] Scores are on a scale of 1 to 7 for the General Vitality Scale and Current Feelings of Vitality Scale.
[b] Scores are on a scale of 1 to 5 for the Athlete Burnout Questionnaire.
[c] Scores are on a scale of 1 to 4 for the Activation-Deactivation Adjective Checklist.

there is considerable evidence that consuming foods or beverages, particularly those high in CHO, before training is beneficial for physiological function and performance (Achten et al., 2004; Coggan and Coyle, 1991; Costill et al., 1988). Therefore, coaching staff may want to encourage breakfast consumption before morning swim practice, and addressing the reasons swimmers do not eat before practice may aid in doing so. For example, providing a low-volume, high CHO food or beverage that is quick to consume and requires little digestion may address the swimmers' concerns of "avoidance of feeling nauseous/ill", "lack of time", "lack of access to food", and "lack of hunger".

This field-based study of the effect of CHO supplementation before morning swim practice on affect in swimmers failed to support previous findings from a laboratory-based study of CHO supplementation and affect in athletes (Backhouse et al., 2005) where conditions were more tightly controlled. In addition, the differences between type of exercise and CHO supplementation regimen may be factors contributing to the discrepancy in results between studies: the study by Backhouse et al. (2005) was conducted in cyclists during a bout of prolonged cycling and the CHO ingestion occurred during exercise, whereas the present study investigated swimmers and CHO was ingested prior to exercise. Variation in dietary habits between supplement and placebo conditions (which was not assessed) may have masked our ability to detect an effect of CHO supplement, although we assume there was little difference in dietary intake within the short time period of the study. Additionally, the short duration of the present study may have limited our ability to detect an effect of treatment. However, a strength of this study was the randomized crossover design which helps control for unplanned variation (such as with habitual diet) and decreases within-subjects variability by making each subject his or her own control.

Conclusion

Although we did not find an effect of CHO supplementation on affect or vitality in swimmers in this field-based experiment, there is evidence in the literature that CHO administration has beneficial effects on both physiological and psychological indices in athletes (Achten et al., 2004; Backhouse et al., 2005; Coggan and Coyle, 1991; Costill et al., 1988). A longer field-study of pre-workout CHO supplementation in swimmers is needed to verify if there is indeed no effect of CHO supplementation on affect or other psychological factors. If practical applications of laboratory-based findings on nutrition and affect were to show benefit in swimmers, these applications could be used to improve affect and mood in swimmers, which is associated with sports performance (Raglin, 2001).

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Key points

- Pre-workout carbohydrate did not affect post-workout measures of vitality or affect in collegiate swimmers.
- "Avoidance of feeling nauseous/ill" and "lack of time" were the most frequent reasons reported by swimmers for forgoing breakfast before morning swim practice.
- A longer trial of carbohydrate supplementation is needed to verify if there is indeed no effect of pre-workout carbohydrate on post-workout measures of vitality or affect in swimmers.

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