GSL Journal of Nutrition and Metabolism

Global Scientific Library

Original Article

The Use of Milk as Hydrating Beverage after Cycle Ergometer Exercise Impacts on Food Patterns?

Cássia Pegoretti[1], Patrícia L Campos-Ferraz[1], Fúlvia de Barros Manchado-Gobatto[1], Rodrigo Ferreira de Moura[2], Homero Gustavo Ferrari[1], Caroline Dário Capitani[1], Diogo Thimoteo da Cunha[1] and Adriane Elisabete Costa Antunes[1]*

[1]School of Applied Sciences, State University of Campinas, Brazil

[2]School of Medical Sciences, State University of Campinas, Brazil

Abstract

Background: Assess hydration by drinking milk and water in different proportions after exercise and the impact of food consumption on the pattern of physically active.

Methods: A randomized cross over clinical trial was designed in order to evaluate the use of milk as a hydrating beverage after exercise. Five adults of both sexes were submitted to a stationary bicycle exercise carried out in a 2:1 effort/pause ratio, with Heart Rate (HR) variations between 80 and 110% of the anaerobic threshold HR, until the participants lost 1.5% of their initial body weight. Skimmed Milk (SM) or SMand Mineral Water (SMW) in different orders of offer were compared to mineral water (W) alone as the control, and offered randomly to the volunteers until 150% of the body weight loss had been recovered. After each test, the subjects filled in a 3-day food record to assess the effect of each beverage combination on the subsequent macro and micronutrients intake.

Results: The results showed no difference amongst the beverages (SM, SMW or W) with respect to hydrating capacity; however, when SMW was taken, the volunteers showed an increased calorie intake, an adequate intake of calcium, phosphorus and vitamin B2 and an intake of vitamin D close to its upper level. In conclusion, SMW was considered adequate for hydration purposes and its use should be recommended considering individual aspects.

Keywords: Physical exercise; Stationary bicycle; Hydration; Skimmed milk; Mineral water; Dietary intake

Background

Hydration plays an important role in sport due to its influence on performance, for both professional and amateur athletes [1]. Consequently, the loss of body water is related to a decrease in performance and may be influenced by environmental conditions such as temperature and humidity, gear and clothing and exercise duration and intensity [1,2].

The intake of beverages containing sodium, potassium and carbohydrates during exercise has been recommended by American College of Sports Medicine in order to maintain adequate hydration status and reduce body weight loss to less than 2% [3]. In this scenario, the intake of skimmed milk or milk proteins by adding them to hydrating beverages arise as an option. Pioneer work by Seifert et al., [4] showed that a sports beverage containing carbohydrates, electrolytes and 1.5g/100mL of milk proteins showed better hydration results than the carbohydrate and electrolytes beverage without the milk proteins or plain water. In 2007, the use of skimmed milk as a rehydrating agent was compared to a regular sports beverage and water, and the results favored skimmed milk [5].

However, no data were found in the literature on the effect of skimmed milk on food patterns when used as a rehydrating agent, since its use may lead to an increase in the intake of macro and micro nutrients in the diet. Of note, lactose should be highlighted since its increased consumption may be related to discomfort even in lactose tolerant people. Hence the aim of this study was to evaluate the use of Skimmed Milk (SM) or Skimmed Milk and Mineral Water (SMW) in different order of administration, as compared to mineral water alone (W), after exercise. A secondary goal of the study was to analyze the impact of the consumption of skimmed milk for hydration purpose in the dietary intake of calcium, phosphorus, vitamin B2 and vitamin D.

***Corresponding Author:** Adriane Elisabete Costa Antunes, School of Applied Sciences, State University of Campinas, FCA-UNICAMP, Limeira, SP, Brazil, Tel: 55 19 37016742; Fax: 55 19 37016680; Email: adriane.antunes@fca.unicamp.br

Received: Jan 13, 2019; **Accepted:** Jan 22, 2019; **Published:** Jan 25, 2019

Material and Methods

Experimental design: A randomized, crossover, longitudinal clinical trial was designed. The casuistry consisted of healthy and physically active men and women and this was a convenience sample. The study was carried out under six different conditions, which consisted of different orders of administrating water and skimmed milk, in order to test rehydration, as follows: 3 times water(W:W:W), 3 times skimmed milk (SM:SM:SM), 2 times skimmed milk and water (SM:SM:W), water and 2 times skimmed milk (W:SM:SM), 2 times water and skimmed milk (W:W:SM) and finally, water, skimmed milk and water (W:SM:W). Surprisingly, when the subjects consumed SM:SM:SM or SM:SM:W or W:SM:SM, they suffered from diarrhea (Figure 1). Thus for ethical reasons, the study had to be redesigned and these first three experimental conditions were eliminated. Thus the final study consisted of three experimental conditions respectively: (W:W:W), (W:SM:W) and (W:W:SM), since these treatments did not cause intestinal discomfort.

Subjects: Nine subjects (4 men and 5 women) were recruited and selected. The sample size was calculated in preliminary tests with the G Power Software considering the effect size of 10% of water retention and the standard deviation of 2.5%. Alpha was set a priori as 0.5% and statistical power was set at 0.8. The recommended group size for these parameters was five per group. The characteristics of the subjects are shown in Table 1. The exclusion criteria were lactose intolerance,

Citation: Pegoretti C, Campos-Ferraz PL, de Barros Manchado-Gobatto F, de Moura RF, Ferrari HG, et al. The Use of Milk as Hydrating Beverage after Cycle Ergometer Exercise Impacts on Food Patterns?. GSL J Nutr Metab. 2019; 1:102.

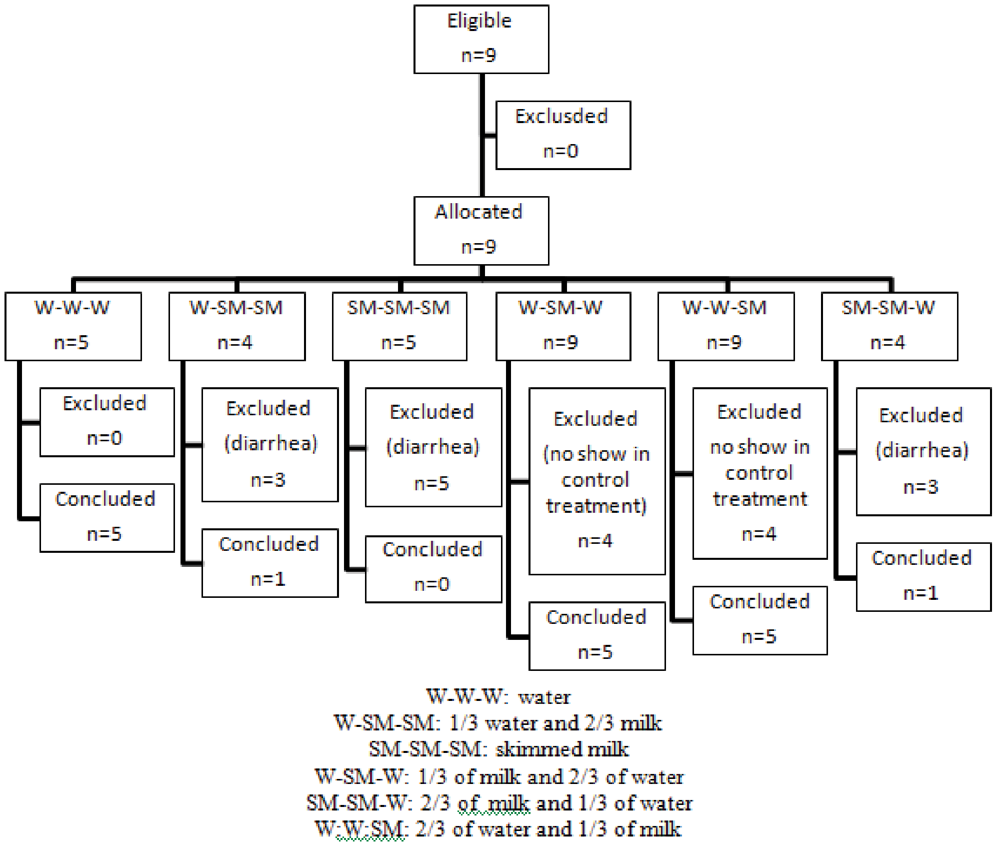

Figure 1. Fluxogram of the subjects. Nine healthy and physically active subjects were invited to participate in the study by the researcher. They belonged to the same physical gym where the experiments were performed. Treatments that caused diarrhea and hence featured a great number of exclusions were abolished. Of the six original drink combinations, only the three with 5 subjects concluded were considered.

allergy to milk proteins or any other negative reports on milk intake, and impossibility of participating in all the tests or carrying out physical exercise. They were classified as physically active individuals according to the IPAQ-short version questionnaire. They all volunteered to participate in the study and read and signed the informed consent. The experimental design was approved by the School of Medical Sciences, State University of Campinas, Ethics Committee (n. 423.685).

Experimental Protocol*:* The study took place in a private fitness facility. Briefly, for four weeks, the subjects were asked to go to the gym for the morning period (07h00 to 13h00). The first day of the study consisted of the determination of the anaerobic threshold heart rate (AnHR); the other three days consisted of a dehydration exercise protocol followed by the consumption of one of the three combinations of beverage described above. All of the protocols were carried out with a seven day interval between them. Urine was collected before, during and after exercise, as described below and the experimental design is shown in Figure 2. Room temperature was set as 22-24 degrees Celsius.

Hydration Beverages: The beverages used in this study were skimmed milk (0.5% fat, Molico, Nestlé, SP, Brazil) (SM) and commercial mineral water (Minalba, SP, Brazil) (W). The temperature at the moment of ingestion was 6°C. The total volume of hydration drink ingested the 150% of the body weight was lost during dehydration protocol.

Assessment of Anaerobic Threshold Heart Rate (AnHR): a progressive cycle ergometer test, (CYCLE Movement LX 120®) was performed for the determination of LAn of each volunteer by enzymatic method [6], based on the blood lactate responses and records heart rate of the sample (Polar®, model RS800), a week before the dehydration protocol. Also, along the progressive test, subjects showed a value on the scale of perceived exertion [7] at the end of each stage. This procedure was adopted in order to match and individualize the intensities of physical effort in the dehydration protocol tests to assure that all subjects were submitted to the same work load.

Anthropometry: The body weight was determined using an OMROM BF511 digital scale with a precision of 0.01kg. The height was measured using a portable AVANUTRI stadiometer with a precision of 0.1mm. The waist circumference was measured using an inextensible metric tape [8]. The Body Mass Index (BMI, kg/m^2) was assessed according to the body weight and stature, and the subjects classified according to WHO [8,9]. The body composition was assessed from the skinfolds (biciptal, triciptal, subscapular, suprailiac) according to Durning and Wolmersley [10]. The skinfolds were measured in the right hemisphere using a LANGE plicometer with a precision of 0.5mm. An average of three assessments was calculated and used in the author's equation (above) in order to assess body density. The body density was then inserted into the Siri equation [11] to assess the body fat.

Dehydration Protocol: the participants were asked to refrain from both caffeine and alcohol, not to carry out any vigorous exercise for 24h before the tests and to maintain their normal food intake until 23h00

Table 1: Characterization of the subjects.

Parameters	Average ± SD	
	Men	Women
	(n=2)	(n=3)
Age (years)	33±0.0	32±1.15
Weight (kg)	83.20±3.68	57.20±3.64
Height (m)	1.84±0.06	1.59±0.09
BMI (kg/m^2)	26.06±2.78	22.76±1.44
AC (cm)	88.00±4.24	75.33±3.06
%BF	20.24±1.51	28.39±3.04

SD: standard deviation
BMI: body mass index
AC: abdominal circumference
%BF: body fat percentage

Table 2: Intake of macronutrients, total energy intake, calcium, phosphorus, vitamin B2 and vitamin D intakes from the food records collected and considering the use of 33.33% of SM for hydration.

	FR		FR + H		
	Average	SD	Average	SD	P
VCT (Kcal)	1332.80	357.37	1518.44	392.22	**<0.01**
Carbohydrate (g)	190.54	94.08	216.04	98.03	**<0.01**
Carbohydrate (% of VCT)	55.57	12.81	55.56	11.31	0.99
Protein (g)	62.67	17.75	78.99	17.62	**<0.01**
Protein (% of VCT)	19.83	7.06	21.69	6.32	**<0.01**
Fat (g)	35.54	9.10	37.58	9.38	**<0.01**
Fat (% of VCT)	24.60	6.62	22.74	5.68	**0.01**
Calcium (mg)	637.69	259.14	1489.39	312.85	**<0.01**
Adequate calcium intake (%)	63.77	25.91	148.94	31.28	**<0.01**
Phosphorus (mg)	569.51	89.28	1003.01	113.84	**<0.01**
Phosphorus Adequacy (Z-Score)	-0.02	0.38	0.91	0.21	**<0.01**
Vitamin D (mcg)	1.03	0.75	46.93	11.77	**<0.01**
Vitamin D adequacy (%)	20.55	15.12	938.55	235.40	**<0.01**
Vitamin B2 (mg)	0.76	0.27	2.09	0.33	**<0.01**
Adequacy of vitamin B2 (Z-Score)	-0.02	0.03	0.11	0.03	**<0.01**

TCV: Total Calorie Value
FR: Normal Intake, according to food records
H: Hydration with 33.33% skimmed milk intake

on the previous day. On the day of the test, they had to ingest 500 mL of mineral water 90 min before the scheduled time of the tests. Upon arriving at the test site, in fasting, they were encouraged to urinate, and the density and osmolality of the urine sample registered in order to guarantee the same initial hydration condition. The volunteers were then weighed before starting the dehydration protocol. This protocol consisted of bouts of 9 min intermittent cycling exercise in a 2:1 exercise/pause ratio fashion, at an intensity of 80-110 percent of the AnHR. After each bout, the subjects stopped the exercise to assess body weight until 1.5% of body weight was lost. HR, blood lactate and the subject perceived effort rate were assessed according to Foster [7] after each bout and at the end of the test. The volunteers were familiarized to the scale procedure prior to the test. Lactate was also assessed at the end of the test.

Rehydration Protocol: After the dehydration protocol described above, the rehydration process started. During the next 60 minutes, the subjects consumed (W:W:W) or (W:SM:W) or (W:W:SM) at random, followed by the recovery protocol, which consisted of a three-hour period during which the volunteers could urinate as much as they wanted. The whole urinary volume was recorded and the last urine sample of this period used to assess osmolality and density.

Hydration and Dehydration Assessment: The volume of urine produced during the recovery period was recorded and used to calculate water retention (total liquid intake minus the total urine produced). Urinary density was evaluated by refractometry (Uridensrefractometer) and osmolality by the freezing point analysis in a clinical laboratory. The urinary density values were used to determine the hydration status of the subjects taking part in the study according to Armstrong et al., [12], for adults. Subjects showing values within the range from 1.013g / ml to 1.029g / ml were considered euhydrated, values above 1.029g / ml were considered dehydrated, and over hydration was considered when the density values reached 1.001 to 1.012g / ml [13]. To be considered as hydrated the values for urine osmolality should be between 442-1.052mOsmol / kg and values above 1,052 mOsm / kg designated the dehydrated state [12].

Food Record: The participants were instructed to maintain a Food Record (FR) for three days to assess the impact of SM consumption on the increase in calories, macronutrients and micronutrients such as calcium, phosphorus, vitamin D and B2 in the context of their habitual food intake. The food records were assessed by the Evaluation and Prescription Nutrition Software, Avanutri, version 4.0, and in order to calculate the food intake hydration and nutritional values of the beverages (W:W:W, W:SM:W and W:W:SM) for each participant, the nutrition values were added to their previously collected food record.

Protein, carbohydrate and lipid consumptions were compared according to their percentage contribution to the Total Caloric Value (TCV), considering the DRIs [14] as the reference point. The estimated average requirement values were used [14] to assess the intakes of calcium, phosphorus, vitamin D and B2, with adjustment in percent for the calcium value and using the z-score for the others.

Statistical analysis: the normality and homoscedasticity of the data were assessed by the Shapiro-wilk and Levene tests, respectively. To confirm the assumptions a general linear model was adopted. Two experiments were conducted: a) factorial design with two different moments (before and after exercise) and different rehydration protocols (W:W:W, W:SM:W and W:W:SM) with urinary density as dependent variable and another similar model with urinary osmolarity; b) factorial design with three different moments (before exercise, after exercise and after hydration and different rehydration protocols (W:W:W, W:SM:W and W:W:SM) with body weight as dependent variable. The results were analyzed using the Statistical Package for Social Sciences (SPSS) v.15.0.1, with a significance level of $p < 0.05$.

Results

Subjects: the male and female subjects were classified as pre-obese and normal weight, respectively; and the percentage of body fat indicated above average values for both, but without the risk of diseases associated with obesity [15]. The waist circumference for both genders was appropriate according to WHO [8] (Table 1).

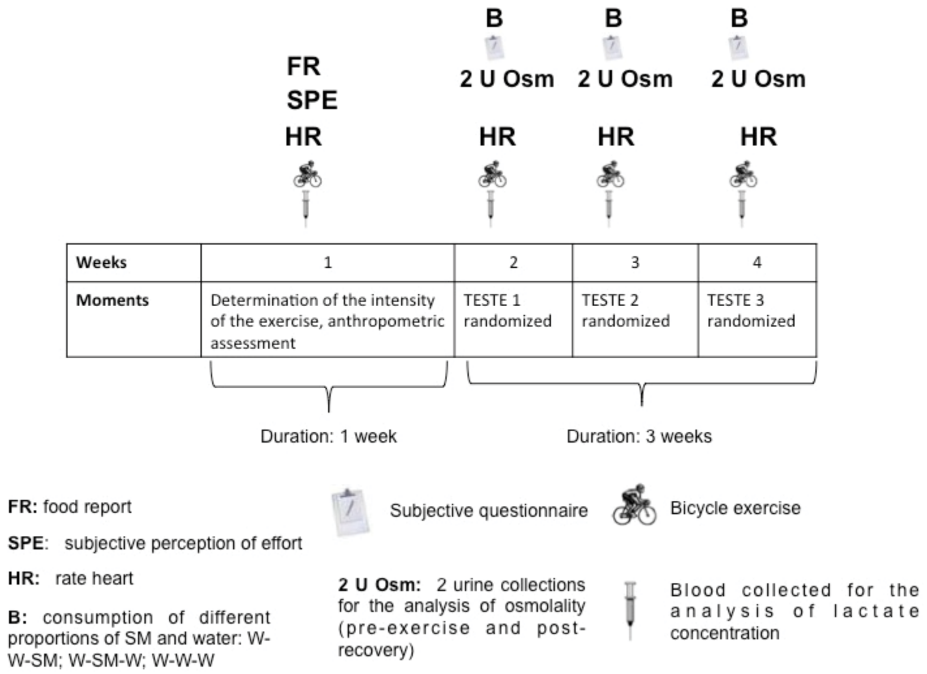

Figure 2. Experimental design.

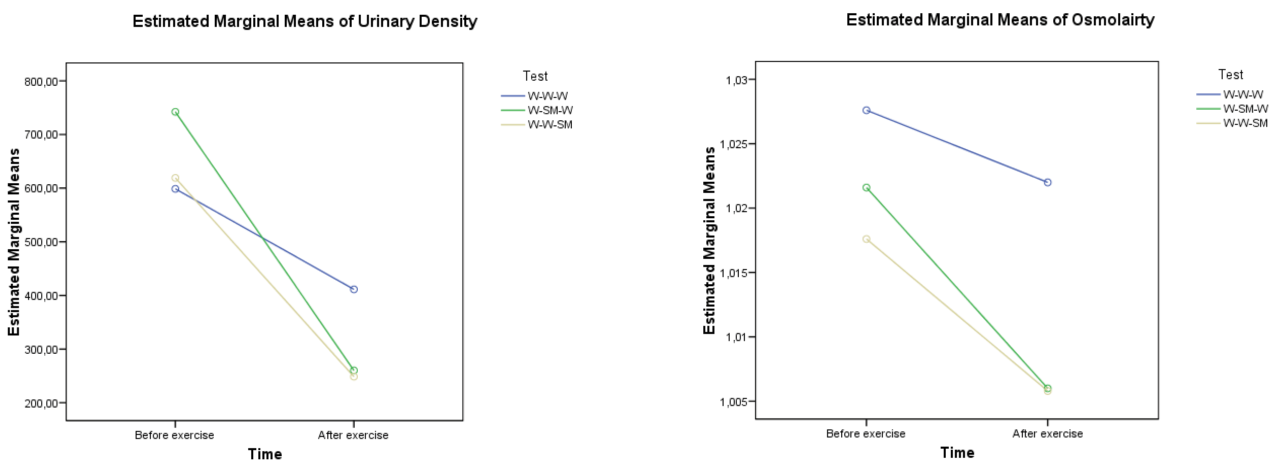

Figure 3. Comparison of urinary osmolality and density between groups 1 (W-W-W), 2 (W-SM-W) and 3 (W-W-SM). W-W-W: just water; W-SM-W: consumption of water, skimmed milk and water; W -W- SM: two intakes of water and 1 of skimmed milk.

Dehydration and Hydration Phases: The exercise was carried out at a mean temperature of 25.4 ± 1.40°C and the dehydrating protocol resulted in similar losses of total body mass for both groups (p = 0.99), representing a mean body weight loss of 1.54% per group (SD 1.52 W:W:W); 1.60% (SD 0.16 W:SM:W) and 1.54% (SD 0.16 W:W:SM). Since there was no difference among the groups for the body mass loss, the total volume of hydration drink ingested was also similar (p = 0.85): 150% of the body weight was lost during dehydration protocol.

Urinary Volume and Water Retention: The total volume of urine produced during the recovery period after consumption of the beverages was similar for the different groups (p = 0.19); as well as water retention (p = 0.79), with no significant difference.

Osmolality and Urinary Density: The urinary osmolality and density were analyzed in the pre and post exercise recovery period for the different study groups. The results for the comparisons between groups 1 (W:W:W); 2 (W:SM:W) and 3 (W:W:SM) showed no significant differences for either density (p = 0.085) or urinary osmolality (p = 0.12). Only an expected difference between time (before and after exercise) was observed for dessity (p=0.006) and osmolality (p=0.05) (Figure 3).

The pre exercise osmolality and density values for these groups showed euhydration (osmolality: W:W:W = 598.6; W:SM:W = 742.2; W:W:SM = 619 and density: W:W:W = 1.0276; W:SM:W = 1.0216; W:W:SM = 1.0176). On the other hand, the values obtained after recovery showed the presence of hyperhydration after the consumption of W:SM:W (osmolality = 260.2 and density = 1.006) and consumption of W:W:SM (osmolality = 248.6 and density = 1, 0058), however these differences were not significant. The data showed that the hydration caused by the consumption of W:SM:W and W:W:SM respectively, was similar to that obtained by the hydration with W:W:W.

Food Intake: The Total Caloric Value (TCV) increased significantly with the consumption of SM for hydration ($p < 0.01$), and the average value of TCV in the food pattern group according to the food records was 1,332.80 kcal, which increased to 1,518.44 kcal with the intake of milk for hydration (Table 2).

The protein, carbohydrate (CHO) and lipid intakes in the dietary pattern estimated from the food records (FR) and food records associated with hydration (H) in W:SM:W and W:W:SM (FR + H) presented the recommended ranges for each nutrient according to the DRIs (2005). The protein intake was 19.83% and 21.69% for FR and FR + H respectively ($p < 0.01$), which was in the proper range of 10-35% of the TCV. The carbohydrate intake for FR and FR + H was 55.57% and 55.56%, respectively, which was considered adequate, as it should range from 45 to 65% of the TCV. The lipid intake was 24.60% and 22.74% for FR and FR + H respectively ($p < 0.01$), and was also considered adequate, as it should range from 20 to 35% of the TCV (Table 2). Even though within the range for the recommended protein intake, the CHO and lipids showed significant differences in grams between the FR and FR + H when employing 33.33% milk (W:W:SM and W: SM:W) ($p < 0.01$).

The consumption of SM significantly increased the intake of the minerals calcium (FR = 637.69mg; FR + H = 1489.39 mg) and phosphorus (FR = 569.51mg; = FR + H 1003.01mg) as compared to the habitual intake of the individuals ($p < 0.01$) (Table 2). By analyzing this increase in relation to the DRIs, it appears that for the mineral calcium, the use of SM for hydration gave a value above 100%, whereas the standard food pattern only reached 63.7% DRI ($p < 0.01$). The consumption of phosphorus was inappropriate according to its z-score value but with the SM for hydration, adequate intake was achieved ($p < 0.01$) (Table 2).

The consumption of vitamin D significantly increased when SM was used for hydration (FR = 1.03mcg / g and FR+ H = 46.93mcg / g; $p < 0.01$), demonstrating suitability of 938.55% ($p < 0.01$). Vitamin D has an upper tolerable intake level (UL) of 50 mcg, representing 1000% adequacy, thus the consumption of SM for hydrating purposes increased the vitamin D intake without representing an intake equal to or above the UL (Table 2). It should be noted that the milk used in the study was enriched with vitamin D.

Likewise, hydration significantly increased the vitamin B2 intake as compared to the standard diet (0.76mg and 2.09mg for FR and FR + H, respectively; $p < 0.01$). The dietary pattern for this nutrient had a usual intake below the recommended value and hydration with SM increased this consumption (Table 2).

With the consumption of SM for hydration, only one participant reported gastrointestinal discomfort in the period after the tests.

Discussion

Skimmed milk has more calories than commercial hydration beverages and water, and may increase the gastric emptying time [16]. Calbet and MacLean [17] reported that the gastric emptying of milk is 14% slower than that of drinks containing carbohydrates and electrolytes, and any delay in gastric emptying reduces the passage of stomach fluid to the small intestine and consequently into the peripheral circulation, by limiting the decrease in serum osmolality and thus inhibiting urine production [5].

In 2006, Seifert et al., [4] made the first study using milk proteins in a hydrating carbohydrate drink (4:1 carbohydrates/proteins) and found a lower urine output with the use of this drink, in a protocol were the subjects dehydrated until a 2,5% of body weight loss. Subsequently Shirreffs et al., [5] evaluated hydration with SM, SM + NaCl and water, and the treatments containing SM showed a smaller urine volume compared to plain water, resulting in maintenance of the euhydration state or even with positive net fluid balance when compared to plain water or sports beverages [5]. The studies with the addition of milk proteins or milk itself for hydration continued, and some showed a smaller urine output as a result [18,19], although others found no significant differences [20-22].

Interestingly, when milk proteins were offered in an increased osmotic solution (e.g. 2:1 protein to carbohydrate ratio), the results in urine output were not different from the lowest osmolality solution [19]. The studies which showed a negative or not different result with milk proteins in urine output used solutions with carbohydrates and 20g/l milk protein (2%) [19]. Amount three times higher than the regular amount of proteins in the milk; in addition, form of administration of milk, weight loss and rehydration period were slightly different from our protocol, making it difficult to compare the results. In these specific studies, although no differences in urine output were found, milk proteins added to a carbohydrate solution ameliorated plasma volume or plasma albumin compared to the drinks which did not contain milk proteins.

In line with these two studies, the results of this study showed no significant difference between the consumption of SM associated with W and the consumption of W alone in water retention. The hypotheses that the consumption of W alone would produce a greater volume of urine in the other groups, and would culminate in a great consumption of diluted liquid, quickly altering the serum osmolality to low values and resulting in inhibition of the ADH hormone, activating the production of urine could not be observed here. As stated before, one of the possible reasons for the discrepancy among the studies that observed an increased water retention versus those which did not observe this phenomenon might be the protocols of administration of milk, and moment of ingestion throughout the rehydration protocol.

According to James et al., [19], the presence of protein in hydration beverages causes an increase in the plasma concentration of amino acids, which, by exerting an osmotic effect results in greater water retention and consequently lower dieresis [19] in addition to enabling a further mechanism for sodium transport in the gut via the protein content of the SM [23].

In general, most of the studies found differences in dieresis and in water retention, demonstrating that there was greater water retention with the consumption of SM or the addition of proteins in sports drinks for hydration [4, 5,18,19,24]. In 2015, Maughan et al. [25] evaluated 13 types of beverages with different characteristics as temperature, amount of macronutrients and micronutrients. The authors found that drinks with a higher amount of nutrients and electrolytes were more effective in rehydration, such as whole milk and skimmed.However, more recent studies with milk proteins did not report such differences [20-22]. The review article of Pegoretti et al., [26] should be consulted for a detailed comparison between the methodologies employed in these studies. These data corroborate those of the present study that showed no difference in the volume of urine produced and the water retention with the use of water alone or water and milk in a 2:1 ratio.

Since most of these studies use milk proteins in hydrating drinks and not just SM, the nutritional differences between their compositions should be considered and therefore one cannot expect the same effects on hydration for SM as for drinks with milk proteins added. In addition, previous studies using SM in hydration used larger amounts of than used in the present study, and thus the present authors aimed to evaluate the W consumption and SM in order to verify better hydration with smaller amounts of SM. It can be seen that by reducing the corresponding volume of SM, no improvement was obtained in the replacement of lost fluids during exercise as compared to the consumption of just W. Therefore, in order to promote greater hydration due to the W consumption, larger amounts of SM must be consumed. However, in the present study, when SM was offered two times during the rehydration protocol, it caused diarrhea in the subjects thus there is a need to individualize the consumption of SM for this purpose.

It is noteworthy that other studies have not shown this effect [5,24,27,28]. Often the effectiveness of post rehydration requires the ingestion of large volumes of fluid in a relatively short period. This can result in gastrointestinal disorders in individuals affected by slight lactose intolerance [5] in the case of drinking milk for hydration purposes. If a 70kg individual loses 2% of body weight (1.4kg) during certain sporting activities, to replenish the lost fluids, he should consume 2.1 liters of liquid. If this replacement is done exclusively by milk consumption, the ingestion of 84 to 105g of lactose will occur, since milk contains from 4 to 5% lactose and this amount is 7 to 8.7 times greater than that tolerated by people who have difficulty in digesting this disaccharide. For example, according to a meta-analysis published by Savaiano et al., [29] such people can only consume up to 12g lactose, and the participants of this study who had diarrhea on consuming SM for hydration received a volume of 650mL of SM, corresponding to the consumption of 26g of lactose in 20 minutes. This case can be associated with mild hypolactasia, which restricts the use of large amounts of milk for the purpose of conferring hydration.

The diet of the sportsman or athlete has been widely questioned and there are positions in the literature that give attention to compliance with essential nutritional recommendations for proper sports performance [3]. In 2000, a study that evaluated the eating habits of cyclists in the Spanish mountain biking selection, showed that younger athletes (16.68 ± 0.99 years) had lower nutritional adequacy than the older athletes (25.33 ± 4.25 years) [30].

Regarding the dietary intakes, in the present study it was shown that an ingestion of SM for hydration resulted in an increased consumption of vitamins D and B2, minerals such as calcium and phosphorus, and also of macronutrients. A study that compared the eating habits of soccer players and cyclists found an inadequate calcium intake by the cyclists, their consumption being less than half the recommended value [31]. It may be feasible to adapt the consumption of calcium in the sport by consuming SM for hydration, but this should be properly evaluated, since it causes an increase in the consumption of other nutrients. In the same study, it was found that cyclists had high protein and carbohydrate intakes as compared to football players and both had inadequate calorie consumptions [31]. In a study published in 2013, evaluating the eating habits of young men practicing aerobic sports, the protein and carbohydrate intakes were deficient in 40% and 84% of the cases, respectively, while the lipid intakes were above the recommended values in 32% of the cases [32]. Although in the present study the consumption of carbohydrates and protein increased with the consumption of SM for hydration (still within the recommended values), the use of SM by cyclists should be evaluated individually so as not to lead to an imbalance in the energy balance. The calorie intake increased in the present study with the consumption of SM, and could thus benefit some athletes who had lower calorie intakes than necessary. A low energy intake was observed in the present study (considering a recommended value of 2,000 kcal per day), however this data may have been the result of under-reporting.

Amongst practitioners of aerobic exercises the intakes of vitamin D and calcium were below the EAR values of 92% and 52%, respectively, and the vitamin B2 intake was unsuitable, according to the study of Wierniuk and Wlodarek [32], and Riebl et al., [33] showed that male cyclists had nutritional disorders that could lead to nutritional deficiencies. Thus the nutritional monitoring of athletes, particularly in cycling, is extremely important in order to improve their nutritional status. Athletes may benefit from hydration using SM, since the present study showed adequacy of the calcium, phosphorus, vitamin D and vitamin B2 values, which were below the recommendations in the dietary patterns of the participants.

Conclusion

The consumption of skimmed milk SM associated with W or water alone (W:SM:W or W:W:SM) was efficient for hydration, but was not superior to the hydration afforded by a water intake only. Therefore both water alone or water plus SM (in the 2:1 ratio) seem to be good choices for hydration, although SM intake in this study results in an increased consumption of specific consumption of macro and micro nutrients.

Acknowledgments

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001 and FAEPEX (Fundo de Apoio ao Ensino, Pesquisa e Extensão) from UNICAMP.

References

1. Kenefick RW, Cheuvront SN 2012 Hydration for recreational sport and physical activity. *Nutr Rev* 70; 2: S137-S142.

2. American College of Sports Medicine. Sawka WN, Burke LW, Eichner, ER, et al 2007 Position stand: Exercise and fluid replacement. *Med Sci Sports Exerc* 39: 377-390.

3. American College of Sports Medicine 2009 American Dietetic Association and Dietitians of Canada. Nutrition and athletic performance. Joint position statement. *Med SciSports Exerc* 41: 709-731.

4. Seifert J, Harmon J, DeClercq P 2006 Protein added to a sports drink improves fluid retention. *Int J Sport Nutr Exerc Metab* 16: 420-429.

5. Shirreffs SW, Watson P, Maughan RJ 2007 Milk as an effective post-exercise rrehydration drink. *Br J Nutr* 98: 173-180.

6. Engle PC, Jones JB 1978 Causes and elimination of erratic blanks in enzymatic metabolite assays involving the use of NAD in alkaline hydrazine buffers: improved conditions for the assay of L-glutamate, L-lactate, and other metabolites. *Anal Biochem* 88: 475-484.

7. Foster C, Florhaug JA, Franklin J, et al, 2001 A new approaches to monitoring exercise training. *J Strength Cond Res* 15; 1: 109-115.

8. World Health Organization (WHO) 1997 Obesity: preventing and managing the global epidemic. Genebra.

9. World Health Organization (WHO) 1995 Physical status: the use and interpretation of anthropometry. Genebra.

10. Durnin JV, Womersley J 1974 Body fat assessed from total body density and its stigmatization from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. *Br J Nutr* 32; 1: 77-97.

11. Siri WE 1961 Body composition from fluid spaces and density. In Techniques for measuring body composition .[J Brozek, A. Henschel, editors.] Washington DC: National Academy of Science 223-244.
12. Armstrong LE, Maresh CW, Castellani J, et al 1994 Urinary indices of hydration status. *Int J Sport Nutr* 4: 265-279.
13. Armstrong LE 2005 Hydration Assessment Techniques. *Nutr Rev* 63; 6: S40-S54.
14. Institute of Medicine 2005 Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. Washington (DC): National Academy Press.
15. Lohman TG, Roche AF, Martorell R 1991 Anthropometric standardization reference manual. Abridged 90.
16. Roy BD 2008 Milk: the new sports drink? A Review. *J IntSoc Sports Nutr* 5; 15.
17. Calbet JAL, MacLean DA 1997 Role of calorie content on gastric emptying in humans. *J Physiol* 498; 2: 553-559.
18. James LJ, Clayton DJ, Evans GW 2011 Effect of milk protein addition to a carbohydrate–electrolyte rehydration solution ingested after exercise in the heat. *Br J Nutr* 105: 393-399.
19. James LJ, Evans GW, Madin J, et al, 2013 Effect of varying the concentrations of carbohydrate and milk protein in rehydration solutions ingested after exercise in the heat. *Br J Nutr* 110; 7: 1285-1291.
20. James LJ, Gingell R, Evans GW, 2012 Whey Protein Addition to a Carbohydrate-Electrolyte Rehydration Solution Ingested After Exercise in the Heat. *J Athl Train* 47; 1: 61-66.
21. James LJ, Mattin L, Aldiss P, et al, 2014 Effect of whey protein isolate on rehydration after exercise. *Amino Acids* 46: 1217-1222.
22. Hobson R, James L 2015 The addition of whey protein to a carbohydrate–electrolyte drink does not influence post-exercise rehydration. *J Sports Sci* 33; 1: 77-84.
23. Schedl HP, Maughan RJ, Gisolfi CV 1994 Intestinal absorption during rest and exercise: implications for formulating an oral rehydration solution (ORS). *Med Sci Sports Exerc* 26: 267-280.
24. Watson P, Love TD, Maughan RJ, et al, 2008 A comparison of the effects of milk and a carbohydrate-electrolyte drink on the restoration of fluid balance and exercise capacity in a hot, humid environment. *Eur J Appl Physiol* 104: 633-642.
25. Maughan RJ, 2015. A randomized trial to assess the potential of different beverages to affect hydration status: development of a beverage hydration index. *Am J ClinNutr* 2016; 103; 3: 717-723.
26. Pegoretti C, Antunes AEC, Manchado-Gobatto FB, Capitani CD 2015 Milk: an alternative beverage for hydration? *Food Nutr Sci* 6: 547-554.
27. Volterman KA, Obeid J, Wilk B, et al, 2014 Effect of milk consumption on rehydration in youth following exercise in the heat. *Appl Physiol Nutr Metab* 39:1-8.
28. Desbrow B, Jansen S, Barrett A, Leveritt MD, Irwin C, 2014 Comparing the dehydration potential of different milk-based drinks to a carbohydrate–electrolyte beverage. *Appl Physiol Nutr Metab* 39: 1366-1372.
29. Savaiano DA, Boushey CJ, McCabe GP, 2006 Lactose intolerance symptoms assessed by Meta-Analysis: a grain of truth that leads to exaggeration. *J Nutr* 12: 1107-1113.
30. García-Rovés PM, Terrados N, Fernández S, Patterson AM, 2000 Comparison of dietary intake and eating behavior of profe- sional road cyclists during training and competition. *Int J Sport Nutr Exerc Metab* 10; 1: 82-98.
31. Galanti G, Stefani L, Scacciati I, Mascherini G, Buti G, Maffulli N 2014 Eating and nutrition habits in young competitive athletes: a comparison between soccer players and cyclists. *Transl Med UniSa* 11: 44-47.
32. Wierniuk A, Wlodarek D, 2013 Estimation of energy and nutritional intake of young men practicing aerobic sports. *RoczPanstwZaklHig* 64; 2: 143-148.
33. Riebl SK, Subudhi AW, Broker JP, Schenck K, BerningJR, 2007 The prevalence of subclinical eating disorders among male cyclists. *J Am Diet Assoc* 10**7:** 1214-1217.

Citation: Pegoretti C, Campos-Ferraz PL, de Barros Manchado-Gobatto F, de Moura RF, Ferrari HG, et al. The Use of Milk as Hydrating Beverage after Cycle Ergometer Exercise Impacts on Food Patterns?. GSL J Nutr Metab. 2019; 1:102.