The effect of milk consumption with different temperatures after resistance exercise on appetite and energy intake in active girls: A pilot study

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Abstract

Study aim: The aim of this study was to investigate the effect of milk consumption with different temperatures after resistance training on appetite and energy intake (EI) in active girls.

Material and methods: Ten healthy female athletes (age: 21.9 ± 3.07 years) completed 2 trials with 1 week apart in counterbalance and crossover fashion. In overnight fasting state, subjects did resistance exercise (70% of 1RM for 5 movements) and then consumed 250 ml of milk at 60°C or 2°C. One hour after exercise, a meal was served to all subjects for lunch. Subjects filled in the appetite questionnaire 4 times and calorie intake was measured on the day of exercise and 24 hours after.

Results: Paired t-test showed that the lunch EI after consuming cold milk was significantly lower than hot milk (p = 0.003). Also, the 24h EI in exercise day was significantly lower in cool vs. hot milk consumption (p < 0.001) and this reduction was not offset the next day. There was no significant difference in next 24h EI, macronutrient composition and appetite between the two situations.

Conclusions: The results of the present study showed that consuming low temperature milk after resistance exercise can be a useful strategy to reduce EI that can be used for weight loss programs.

Keywords: Appetite – Resistance exercise – Energy intake – Milk – Temperature

Introduction

Common strategies for reducing body weight are to increase physical activity and reduce energy intake in order to negative energy balance. Changes in energy intake can play a decisive role in the effectiveness of physical activity on weight loss. But there are many factors that affect energy intake. For example, recent studies have measured the effect of ambient temperature on appetite hormone levels after exercise and have shown that exposure to cold temperatures during exercise reduced exercise-induced ghrelin responses [12, 13]. The question arises that if the ambient temperature has an effect on the perception of appetite, can the temperature of the food or drink also have such an influence?

Post-exercise protein drinks have been identified as a beneficial factor for recovery [3]. Milk is known as an excellent recovery product following both resistance and endurance exercise. This is due to the fact that milk’s carbohydrates enable rebuilding of muscle glycogen stores, whilst the milk’s proteins effectively stimulate the synthesis of muscle proteins [11]. However, ingestion of milk after exercise not only enhances gains in muscle mass but also mitigates exercise-induced muscle damage [2, 16]. Recently, it has been emphasised that in addition to supporting post-exercise recovery, milk may contribute to the negative energy balance, showing the potential to suppress appetite [14]. Many studies have confirmed the satiating effect of milk or milk drinks, however they have obtained different results regarding the duration of appetite reduction [17]. Moreover, not much research has been done on the effect of different temperatures of milk (or any other food) after exercise on appetite and energy intake. Fujihira et al. showed that consuming protein-containing drink at 60°C after exercise increases energy intake and that this increase may be related to the modulation of the gastric motility [7]. In another study, researcher demonstrate that
consuming water at 2°C reduces energy intake and this reduction may be related to the modulation of the gastric motility [8].

The appetite-suppressing effect of milk may be important for athletes seeking weight loss. This is the main goal of exercise for many individuals, especially women. It should be emphasized that according to previous studies, physical exercise affects appetite differently in women and men. It has been proven that women respond to a negative energy balance caused by exercise with a higher appetite and thus food intake than men [9]. Although this effect depends on several factors, including the type of exercise, nutritional and training status, it appears that after an energy deficit, women’s compensatory energy intake tends to be more pronounced and stronger than men’s [10].

For people doing resistance training, it is important that the development of muscle mass is not accompanied by an increase in body fat. Therefore, they are looking for food that, by providing ingredients that ensure the optimal post-exercise regeneration, will also protect them from excessive energy intake. Milk and dairy products, due to their composition and effect on appetite, seem to meet these expectations. However, so far no study has examined the effects of different milk temperatures after resistance exercise on appetite and energy intake. Knowing this, in addition to weight control, can also be used in weight limit sports. Therefore, the present study aims to investigate the effect of the milk consumption of various temperatures after resistance exercise on energy intake and appetite in young active girls.

Material and methods

Subjects

A total of 10 active (3 sessions regular exercise per week) girls, ranging in age from 18 to 28 years old, participated in this study. Prior to testing and after explanations of the study design and potential risks, all the subjects signed informed consent and completed a health-scanning questionnaire. Also the ethics committee of the university for testing of human subjects confirmed the study’s compatibility with the 1964 Declaration of Helsinki and its later amendments. They were prohibited from exercising outside the training program. Selection criteria were: physical health, no weight changes greater than 2 kg in the last 6 months (declaration by the subjects), no smoking, regular menstrual cycles, no lactose intolerance and not taking drugs, especially drugs that affect appetite.

Research protocol

A cross-sectional and counterbalanced methods was performed. In overnight fasting state, the subjects started warming up at 10 am after completing the appetite questionnaire. Then subjects performed resistance exercise including five movements of bench press, leg press, seated cable rows, leg extension, and standing lower leg raises, in 2 sets with 10 repetitions (with 75% 1RM) and 1 set with 12 repetitions (with 70% 1RM) and 1 minute rest between sets. Immediately after resistance exercise, they received 250 ml of hot (60°C) or cold (2°C) cow’s milk (fat: 5.8%, carbohydrate: 3.4%, protein: 15.4%) and filled the appetite sheet. A lunch meal was served 60 minutes after exercise. The meal consisted of pasta and soy sauce (40% carbohydrates, 13% protein, 47% fat) and soft drinks so that the composition of the food was fixed for everyone but the amount consumed was ad libitum [17]. All food consumed by the subjects was recorded in the food record sheet until the next day and the amount of energy and percentage of macronutrients were calculated. After a week, the test was repeated and only the temperature of the milk changed.

Appetite

Visual Analogue Scale (VAS) appetite questionnaire were used for assessed appetite in 4 times (before and after exercise, after milk consumption and before lunch). The questionnaire had four questions about appetite, including (hunger, satiety, desire to eat and perception of eating).

Statistical analysis

Shapiro-Wilk test was used to assessment the normality of data distribution. For compare the two situations, we used Wilcoxon Test for appetite and paired t-test for other data. Significance level was set at $\alpha = 0.05$. Data were analyzed using SPSS software version 24.

Results

The characteristics of the subjects are shown in Table 1. The results showed that the temperature of the milk had no effect on women’s appetite measured by VAS.

Table 1. Characteristics of the subjects (Mean values and standard deviations, n = 10)

<table>
<thead>
<tr>
<th></th>
<th>Age [year]</th>
<th>Height [cm]</th>
<th>Weight [kg]</th>
<th>BMI [kg/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means</td>
<td>21.9</td>
<td>158.6</td>
<td>52.6</td>
<td>20.8</td>
</tr>
<tr>
<td>SD</td>
<td>3.71</td>
<td>6.80</td>
<td>9.39</td>
<td>3.14</td>
</tr>
</tbody>
</table>
Milk temperature and energy intake after exercise

Lunch energy intake was significantly higher when subjects consumed high-temperature milk ($p = 0.003$, $t = 4.029$, Cohen’s $d = 1.274$). Also, the average energy intake during the first 24 hours was higher when the subjects consumed high temperature milk compared to when they consumed low temperature milk ($p = 0.000$, $t = 5.481$, Cohen’s $d = 1.710$). But the average energy intake during the second 24 hours was not significant (Figure 2). No significant difference was observed in macronutrients composition in all time (Table 2).

**Figure 1.** Appetite scores in two conditions during all time point

**Table 2.** Macronutrient composition percent of lunch, first 24h and second 24h

<table>
<thead>
<tr>
<th>Time</th>
<th>Carbohydrate</th>
<th>Fat</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>$t$</td>
<td>df</td>
</tr>
<tr>
<td><strong>Lunch</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm</td>
<td>43.6 ± 3.77</td>
<td>0.067</td>
<td>9</td>
</tr>
<tr>
<td>Cool</td>
<td>43.5 ± 5.42</td>
<td>–0.555</td>
<td>9</td>
</tr>
<tr>
<td><strong>First 24h</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm</td>
<td>51.4 ± 11.58</td>
<td>–0.934</td>
<td>9</td>
</tr>
<tr>
<td>Cool</td>
<td>55.7 ± 7.84</td>
<td>0.865</td>
<td>9</td>
</tr>
<tr>
<td><strong>Second 24h</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm</td>
<td>55.5 ± 12.16</td>
<td>0.392</td>
<td>9</td>
</tr>
<tr>
<td>Cool</td>
<td>54.0 ± 9.82</td>
<td>0.392</td>
<td>9</td>
</tr>
</tbody>
</table>

The table shows the mean ± standard deviation (SD) values of carbohydrate, fat, and protein intake during lunch, first 24 hours, and second 24 hours in warm and cool conditions. The $t$-values, degrees of freedom (df), and $p$-values are also provided, along with Cohen’s $d$ effect sizes.
The findings of the present study showed that consuming milk with low temperature compared to high temperature after resistance training causes a decrease in energy intake. More importantly, this reduction was not compensated for the next day, so it seems that if it continues, it can create a negative calorie balance and be effective in weight loss protocols.

In recent research it has shown that consuming a warm protein drink (60°C) after 30 minutes of running at 80% of maximum heart rate significantly increases (15%) energy intake more than a cold protein drink (2°C) in healthy young men. Also the frequency of the gastric contractions with the hot drink was higher than cold drink [7]. The researchers reported similar results for hot and cold water consumption without exercise intervention, and showed that hot water (60°C) consumption increase energy intake by 26% compared to cold water (2°C) [8].

To our knowledge, the present study is the first to investigate the effect of consumption different temperatures of milk after exercise (specialy resistance exercise) on appetite and energy intake. We found 26.9%, 29.7%, 9.1% decrease in ad libitum energy intake with cool milk consumption in lunch, first 24h and second 24h respectively. These findings are consistent with other findings on the temperatur of water [8]and protein drink [7]. Therefore, it seems that regardless of the type of drink, consuming a cool drink with or without exercise can reduce energy intake. In addition, the subjects in the above two studies were young men, but in our study, young women participated, so the effect of drinking temperature seems to be similar, despite the differences in the responses of men and women in energy intake and appetite [5, 6, 9].

In other studies, the effect of exercise in hot and cold ambient on energy intake and appetite has been investigated, for example, treadmill running for 40 min at 70% VO2 peak in the heat (36°C), neutral temperature (25°C), and a resting control (25°C) showed that exercise in a neutral temperature is associated with higher energy intake in the subsequent meal compared with a control, whereas exercise in the heat is not [18]. Also, Wasse et. al demonstrated that compared with a temperate (20 °C) environment, 1 h of running followed by 6 h of rest tended to decrease energy intake from 2 ad libitum meals in a hot (30 °C) environment but increase energy intake in a cool (10 °C) environment [19]. There seems to be more inconsistencies in the effect of air temperature than food temperature on energy intake and appetite.

There is evidence showing that the appetite suppressor effect of milk can be related to lactose [1]. On the other hand, hydrolysis of lactose is affected by temperature [15]. Therefore The results of the present study can be interpreted from this point of view. However, the suppressive appetide properties of milk can also be related to the protein, fat and Calcium in it.

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It is clear that the effectiveness of exercise training in losing weight depends on the response of energy intake to exercise, and if the energy intake increases, the result...
may not be desirable. However, in the present study, it was found that consuming low-temperature milk can reduce energy intake, and this is very useful for weight loss. In another way, some people do resistance exercise for weight gain. In this case, it is better to increase energy intake. Therefore, the results of this study suggest that hot milk should be used after weight training to increase energy intake.

Our study was done on active girls with normal weight, however, the issue of weight control in athletes is also raised so it is not clear that these results also apply to people with obesity or overweight. Also, future research can also be done on the temperature of foods (eg ice cream vs other protein sources) to determine if the same results can be achieved for drinks and foods. It would be worth conducting such a study also among men, as well as in both sexes, observing their reaction to other efforts, especially endurance ones. People who perform this type of training often have problems with appetite [4], so controlling the appearance of this feeling by appropriate selection of the temperature of consumed drinks or meals would be very useful. It also seems valuable to strive to increase the number of people surveyed in the above manner.

In conclusion, it seems that consuming 250 ml of milk at 2°C after 70 % 1RM of resistance exercise decreased ad libitum energy intake compared with consuming milk at 60°C in active young women. Therefore, it is suggested that the post-exercise consumption of cool milk is useful for decrease energy intake.

Conflict of interest: Authors state no conflict of interest.

References


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