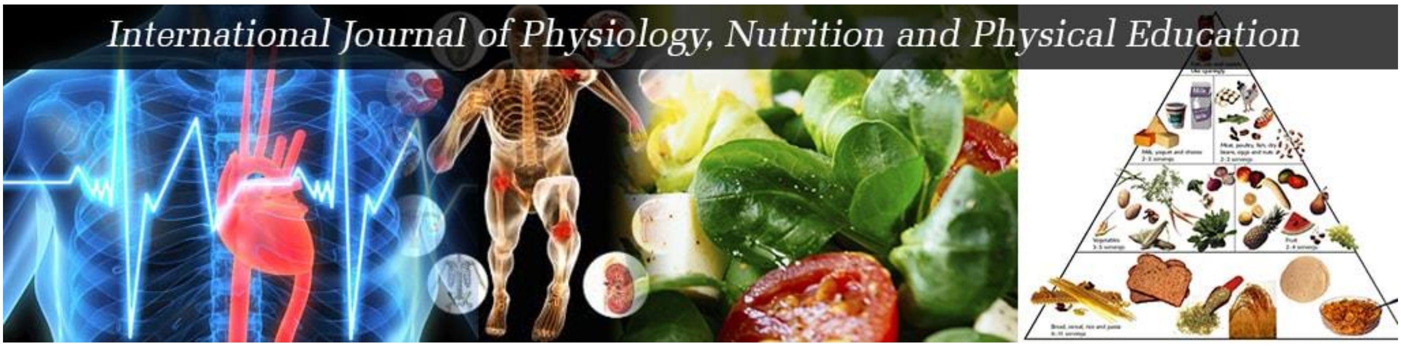

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A systematic review on impact of enrich protein milk for recovery muscles function for athletics

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Abstract
Dairy products are thought to improve recovery after both resistance and endurance exercises due to their nutritional proprieties. We systematically reviewed the effects of dairy product intake on exercise performance and recovery of muscle function in humans. A literature search was conducted in the MEDLINE (via PubMed) and Web of Science databases from their inception to 15th April 2018. The initial search retrieved 7708 articles, and a total of 11 studies were finally included after applying inclusion and exclusion criteria. All the selected studies were conducted with protein milk. Whereas some studies found significant positive effect of protein milk on exercise performance and recovery of muscle function, others did not find any effect. These controversies could be due to the heterogeneity of protein milk ingestion (e.g., amount of protein milk, timing of consuming the protein milk), to the type of intervention, and to the large erogeneity of outcomes measured. Limited studies exist examining the effects of protein milk consumption and its influence on exercise performance and recovery of muscle function, therefore further studies are needed to draw more definitive conclusions.

Keywords: Dairy product, muscle damage, muscle recovery, resistance training, endurance training

1. Introduction

There is evidence that proper nutritional intake is a key factor in optimizing exercise performance as well as adaptation to training (e.g., positive stimuli for protein synthesis in skeletal muscle) and recovery of muscle function (e.g. increase the recovery between training sessions or competitions, decrease the symptoms of delayed onset muscle soreness, etc.) [1, 2]. High exercise performance requires very controlled nutritional intake [3] and timing [4] before, during and after exercise to maximize exercise-induced adaptation and to shorten recovery after exercise, however the impact of either the type, composition or timing of the nutrient is still not known. Protein intake has a great impact on muscle damage repair, facilitating the recovery of muscle function (e.g. muscle strength, muscular power production, muscular stiffness, etc.) and muscular protein synthesis [1, 2]. For both hypertrophy and recovery, a positive muscle protein net balance, i.e., a higher muscle protein synthesis than muscle protein breakdown, is necessary [5]. When the rates of muscle protein synthesis and degradation increase [6, 7], an adequate nutrition is required [8–10] to facilitate the recovery process. For example, about of unaccustomed exercise, especially that including eccentric muscle contractions such as downhill running, can damage contractile proteins, impair muscle function, and induce muscle soreness [11, 12]. In theory, the stimulation of muscle protein synthesis by means of protein or amino acids (e.g. through dairy products ingestion) represents an important skeletal muscle adaptive response to mechanical stress that helps in recovery of muscle function [8, 13, 14]. Dairy products are rich in amino acids, proteins, lipids, minerals and vitamins, and their health benefits have been reviewed elsewhere [15]. These beneficial properties are based on the fact that dairy products, and especially protein milk, contains lactose (carbohydrate), casein and whey protein—commonly in a 3:1 ratio (casein: whey), as well as calcium [5, 15]. Of note is that these other nutrients present in protein milk such as calcium, sodium or potassium could aid in fluid recovery after exercising [5] and this improvement in the hydration state could help the recovery of the skeletal muscle. Furthermore, the aforementioned protein ratio could promote slow digestion and absorption of amino acids [5], which may lead to an increase in the serum amino acid concentration (mainly branched amino acids) [16], however, it is important to note that casein alone or whey protein alone, could increase serum amino acid concentration. These branched amino acids may have a large impact on protein synthesis and muscle metabolism [5] and therefore, helping the aforementioned muscle damage repair process. However, it is important to note that Atherton *et al.* [17] showed that branched amino acids effect on muscular protein synthesis is most likely due to the presence of leucine and not the presence of isoleucine or valine. Furthermore Witard *et al.* [18] reported that muscular protein synthesis stimulation via branched amino acids was ~ 50% inferior compared to a whey protein bolus containing similar amounts of branched amino acids.

Moreover, the nutritional characteristics of dairy products (e.g. protein milk) [19] plus the relatively low price and high availability [20] of dairy products make them a potentially recovery-enhancing product after exercise [5]. This is observed in the current growth of scientific interest in the effects of dairy product intake on exercise performance and muscle function recovery [5]. In this systematically review, we summarize the results of the studies assessing the effect of dairy products on exercise performance and on the recovery of muscle function in humans.

2. Methods

Briefly, we used “dairy products”, “exercise”, “training”, “athletic performance”, “muscle strength”, “muscle fatigue”, and “muscle recovery” among others terms joined with Boolean operators. The reference lists of the retrieved systematic reviews and meta-analyses were reviewed to identify additional studies.

3. Selection criteria

The inclusion criteria used were 1) dairy product and exercise intervention (either chronic or acute) studies. The difference between the intervention and the control group/period should be in the dairy product consumption. Dairy product includes raw and processed or manufactured milk and milk-derived products. Dairy products normally come from cow but could be also from goats, sheep, reindeer, and water buffalo as defined by the National Library of Medicine (PubMed) [22]; 2) conducted in healthy humans, regardless of age or fitness level; and 3) studies including measurements of exercise performance or recovery of muscle function. We included studies that measured exercise performance quantified by fitness parameters such as maximum repetition test and isokinetic dynamometry variables [23, 24]. Moreover, we included studies that assessed muscle recovery function by subjectively measurements [e.g., ratio of perceived exertion and visual analogue scales (VAS)] or objectively measured by the use of blood markers
[(e.g., creatine kinase (CK) and myoglobin)] [25]. If the same data/study was used in different original articles for different purposes, only the report that provided more detailed information about the topic of this systematic review was included. The exclusion criteria used were 1) studies written in languages other than English or Spanish; 2) studies in which any type of protein, flavoring or sweetener was added to the consumed dairy product; moreover, colostrums (e.g., bovine colostrum), chocolate milk and breast milk were excluded from this systematic review; 3) studies in which there was no a control group.

4. Data extraction with results

The following data were collected from each included study: 1) study characteristics (author identification and reference); 2) number of participants and sex; 3) age of the participants; 4) fitness level of the participants; 5) design; 6) groups; 7) exercise intervention; 8) dairy product ingestion (e.g. protein milk ingestion) and placebo ingestion; 9) study outcomes; 10) results; and 11) risk of bias score. Regarding the exercise intervention, those studies including exercises such as sprints series, isokinetic (combining eccentric and concentric contractions) or resistance (e.g. bench press) exercise or training were classified in resistance or high-intensity exercise. Those studies including exercises such as continuous cycling or cycling at different intensities (e.g. 70% peak oxygen uptake) were classified in endurance exercise. Study quality and risk of bias assessment The Cochrane risk of bias tool [25] was used to evaluate the risk of bias in each study. This tool assesses random sequence generations and allocation concealment, performance bias resistance exercise in the protein milk group compared with the values of the placebo beverage group [1]. Cockburn *et al.* [3] also showed that the increase in CK can be blunted after resistance exercise with less protein milk ingestion (500 mL of protein milk instead of 1000 mL of protein milk). These lower increases of CK were observed from 24 to 72 h after exercise-induced muscle damage in the hamstring and protein milk ingestion [9]. Protein milk also attenuated the skeletal troponin I increase after exercise compared with a placebo group (energy-matched carbohydrate solution) [9]. Protein milk did not improve muscle soreness after resistance exercise in other studies [3], whereas it had a positive effect on muscle soreness and tiredness at 72 h post resistance exercise in other [7]. Moreover, protein milk reduced passive soreness in males and females, as well as active muscle soreness (all from baseline to 72 h) in both sexes [2, 9]. Similar results were found in another study that compared protein milk vs. energy-matched carbohydrate solution as a control at 72 h [2, 8]. Finally, passive measurements of muscle soreness (using VAS) showed a benefit of limiting increases in muscle soreness in the group receiving less bolus protein milk (500mL) compared with the high-bolus protein milk group (1000 L) between the baseline and 48 h after exercise and protein milk ingestion [3]. Due to lack of homogeneity in the measurement of exercise performance, and on the covery of muscle function outcomes after resistance or high-intensity exercise intervention doing a meta-analysis was not possible. Effects of protein milk on exercise performance and muscle function recovery after endurance exercise Protein milk before (2 h prior the exercise) endurance exercise improved performance in a 20-km time trial ($P < 0.05$). Moreover, no differences in heart rate were observed between the protein milk group and the placebo group. In another study [3, 5], the mean cycling time to exhaustion was the same on the placebo group trial (39.6 ± 7.3 min) compared with the protein milk group (39.7 ± 8.1 min; $P = 0.879$). Furthermore, no differences oxygen consumption during exercise were found [3, 5]. Finally, there was no effect of protein milk on changes in the rate of perceived exertion after exercise ($P = 0.744$) compared with the placebo group [3, 5].

5. Conclusions

In conclusion, based on the current evidence, it cannot be determined whether protein milk has a positive effect on exercise performance and recovery of muscle function in humans, due to the limited number of studies included in this systematic review. Nevertheless, since protein milk is a source of protein, carbohydrates, calcium and other nutrients, and thus may lead to an increase in the serum amino acid concentration and, therefore, helping the muscle damage repair process. In line with this, some studies included found significant effects of protein milk intake on performance and recovery of muscle function. For these reasons, more and better study designs such as blinding the beverage to both, participants and personnel, generate a random sequence of beverage group, etc. are needed to demonstrate its usefulness as a sport nutrition-related supplement.

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