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Original Study

Effects of Timing of Whey Protein Intake on Appetite and Energy Intake in Healthy Older Men

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A B S T R A C T

Background: Protein-rich supplements are used widely to prevent and manage malnutrition in older adults. We previously showed that 30 g whey protein ingestion, 3 hours before a buffet meal, suppressed energy intake in young, but not in older men. Information about the impact of the timing of ingestion of protein drinks on the suppression of energy intake in older adults is lacking.
Objective: The aim of the study was to determine the effect of the timing of whey protein ingestion on appetite and subsequent ad libitum energy intake in healthy older men.
Design: In a single blind, randomized design, 16 older men were studied on 5 occasions, on which they consumed a whey protein drink (30 g/120 kcal, 140 mL) 3, 2, 1 hour(s), or immediately before a buffet meal, from which ad libitum energy intake was quantified, and isopalatable noncaloric drinks (~1 kcal) at the remaining time points. On the control day, noncaloric drinks were ingested at all time points. Perceptions of appetite and gastrointestinal symptoms were determined, by visual analog scales, throughout the study days.
Results: There was no effect of the timing of protein ingestion on perceptions of appetite and gastrointestinal symptoms ($P > .05$) or energy intake at the buffet meal (3 hours: 888 ± 49 kcal, 2 hours: 879 ± 56 kcal, 1 hours: 909 ± 47 kcal, 0 hour: 892 ± 51 kcal, control: 930 ± 49 kcal, $P = .94$). Total energy intake (ie, preload + test meal) was higher on the protein days compared with control (82 ± 24 kcal increase, $P = .003$).
Conclusions: In older men, ingestion of 30 g protein increased total energy intake, irrespective of the time of intake in relation to the meal. These observations support the use of "pure" whey protein drinks to increase overall protein and energy intake in older adults at risk of undernutrition.

The prevalence of undernutrition in the aging population, which is associated with reduced functional capacity and decreased quality of life, has increased over recent decades.[1–4] A growing awareness of the prevalence, and substantial adverse effects, of the major muscle loss that occurs during aging has stimulated the development of nutritional strategies designed specifically to preserve and/or restore skeletal muscle mass and function. A "common" strategy is the use of supplements, which are usually high-energy drinks rich in whey protein.[5–8] Older people ingest protein in the range of ~40–66 g/d, less than the recommended minimum of 30 g protein intake per meal (ie, ≥90 g/d).[9,10] Despite the widespread use of protein-rich drinks, information about their effects on energy intake in older adults is largely lacking.

In young adults protein is the most satiating of the macronutrients,[11] and the timing of intake affects the suppression of subsequent energy intake. For example, in young women less food is consumed during an ad libitum meal when a preload is administered 30 minutes, compared with intakes at 60 or 120 minutes before a meal.[12] Also, a recent systematic review indicated that, in young and middle-aged adults (18–65 years of age), (1) ad libitum energy intake at a meal is

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suppressed most when a mixed-macronutrient preload is given no more than 30 minutes before the meal, (2) whereas an inter-meal interval of 30–120 minutes suppresses energy intake modestly and, (3) an inter-meal interval of 120 minutes or more is likely to increase total energy intake (ie, preload + test meal), compared with a control day.[13]

To our knowledge only 1 study has evaluated the effect of the timing of supplements on appetite (ie, inter-meal interval) and subsequent ad libitum energy intake in older individuals. Wilson et al[14] reported that total energy intake was higher when a mixed macronutrient preload (300 kcal) was consumed 60 minutes or more before a meal, compared with when the preload was given directly before, the meal in a group of younger [23–35 years of age, body mass index (BMI): 20–25 kg/m^2] and older adults (70–85 years of age, BMI: 21–24 kg/m^2) combined. A limitation of this study was that the potential effect of the timing of supplement intake could only be analyzed as main time-effect (younger and older adults combined) because of the specificity of the study design [ie, 3-factor interaction between age, preload-type (water, high-protein, high-fat, high-carbohydrate), and time (≥60 minutes compared with directly before the meal)].[14] Accordingly, whether the timing of ingestion of a protein supplement influences energy intake in older participants is not known. Despite this, based on the above findings, recommendations have been made that supplements are best given between meals with a substantial time gap between the supplement and the next meal, to maximize overall protein and energy intake.[14–18] We recently reported that administration of both a 30g- and 70-g protein drink (~450 mL) 3 hours before a subsequent buffet meal, suppressed ad libitum energy intake substantially in younger (25 ± 2 years of age; suppression of energy intake after a protein load of 30 g compared with control: 17 ± 3%; 70 g: 12 ± 3%), but not in older (73 ± 1 years of age; 30 g: 2 ± 5%; 70 g: 0 ± 8%), men.[19] These marked differences in suppression of energy intake by protein is not surprising in view of the "anorexia of aging"[4]; healthy aging is associated with a reduction in appetite and food intake.[20]

The aim of this study was to determine the effects of the timing of whey protein intake on appetite and energy intake in healthy older men. Given the lesser suppression of energy intake by protein in older than younger people, we hypothesized that the timing of protein-supplement administration can be much more liberal in older adults so that they can be given closer to meals without a substantial suppressive effect on subsequent ad libitum energy intake.

Methods

Participants

The study included 16 Caucasian older men [age: mean ± standard deviation: 76 ± 6 years of age (range: 66–85 years); body weight: 81 ± 8 kg (67–94 kg); height: 1.75 ± 0.05 m (1.65–1.85 m); BMI: 27 ± 2 kg/m^2 (22–31 kg/m^2)] who were recruited by advertisement. Exclusion criteria were smoking, consuming >10 alcoholic drinks per week, diabetes, gastrointestinal surgery (apart from uncomplicated appendectomy), significant gastrointestinal symptoms (abdominal pain, gastro-esophageal reflux, diarrhea, or constipation), use of medications known to potentially affect appetite, food intake, or gastrointestinal motor function, impaired cognitive function (score <25 on Mini-Mental State[21]), depression (score ≥11 on the Geriatric Depression Questionnaire[22]), and undernutrition (score <24 on the Mini Nutritional Assessment[23]).

The Royal Adelaide Hospital Human Research Ethics Committee approved the study protocol, and the study was conducted in accordance with the Declaration of Helsinki. The study was registered as a clinical trial with the Australian New Zealand Clinical Trial Registry (www.anzctr.org.au, registration number ACTRN12615000070538). All participants provided written informed consent before their inclusion.

Protocol

In randomized order (using the method of randomly permuted blocks; www.randomization.com), each participant was studied on 5 occasions, each separated by 3–14 days. On the protein study days, an oral whey protein load (30 g/120 kcal) was ingested at either 3 (P3), 2 (P2), 1 (P1) hour(s), or immediately before (P0) a buffet meal, and isopalatable, noncaloric drinks (~1 kcal) were consumed at the remaining time points. On the remaining control day, noncaloric drinks were ingested at all time points; [ie, at 3, 2, 1 hour(s), and immediately before the meal]. Participants were blinded to the treatment order. Drinks were served in a covered cup and matched for taste by using diet lime cordial, as per our previous protocol.[19] Protein drinks (30 g/120 kcal, 140 mL) were prepared by dissolving whey protein isolate (Fonterra Research and Development Center, Palmerston North, New Zealand) in 70 mL of water and 50 mL of diet lime cordial (Bickford's Australia Pty Ltd, Salisbury South, SA, Australia). Control drinks were made up of 90 mL of water and 50 mL of diet lime cordial.

Participants were provided with a standardized evening meal [beef lasagna (McCain Foods Pty Ltd, Wendouree, VIC, Australia), ~591 kcal] to consume on the night before each study day at 7:00 PM. They were instructed to fast overnight from solids and liquids and to refrain from strenuous physical activity and alcohol for the 24 hours before they attended the laboratory at the Discipline of Medicine, the University of Adelaide, Royal Adelaide Hospital, at 8:30 AM.

Perceptions of appetite and gastrointestinal symptoms were determined immediately before (during fasting; 0 minutes), after ingestion of each drink (+5 minutes), and at 30-minute intervals until 180 minutes by validated visual analog scales (ie, 0, 5, 30, 60, 65, 90, 120, 125, 150, 180, 185 minutes[24]). Participants were instructed to consume each drink within ~2 minutes. At 185 minutes, participants were presented with a standard, cold, buffet meal, in excess of what they were expected to consume, and instructed to eat freely for up to 30 minutes until comfortably full (185–215 minutes; ~12:00–12:30 PM).[19] The composition of the buffet meal is presented in Table 1.

Measurements

Energy intake

The amount eaten (g) was quantified by weighing the buffet meal before and after consumption. Energy intake (kcal) at the buffet meal and proportions of protein, carbohydrate, and fat (energy-percent) were calculated using commercially available software (Foodworks; Xyris Software Pty Ltd, Spring Hill, QLD, Australia). Energy intake was calculated both as intake at the buffet meal and as the total energy intake; defined as the sum of energy intake at the buffet meal and the energy content of the whey protein preload drink.[19] Absolute (kcal) and percentage suppression of energy intake at the buffet meal (expressed as percent of energy intake of the control day) for a given time of protein consumption compared with control were calculated.

Habitual energy intake was assessed after the initial screening visit by a food diary maintained for 3 successive days, either 3 weekdays or 2 weekdays and a weekend day, and was calculated using commercially available software (Foodworks 8; Xyris Software Pty Ltd).

Perceptions of appetite and gastrointestinal symptoms

Perceptions of hunger, desire to eat, prospective consumption, fullness, nausea, and bloating were rated using a visual analogue scale.[24] The questionnaire consisted of 100-mm horizontal lines, where 0 represented that the sensation was "not felt at all" and 100 represented that the sensation was "felt the greatest." Participants