Load-dependent effects of whey-protein supplements on energy intake, gastric emptying and gut hormone concentrations in men and women

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Background: Protein-rich supplements are used widely by overweight and obese adults aiming to decrease energy intake and lose body weight. In particular, whey protein, a major dairy protein source rich in essential amino acids, is often used. We reported previously that whey-protein ingestion results in a load-dependent suppression of subsequent energy intake in healthy young men. The aim of the study was to determine the protein-load effect of pure whey protein drinks on energy intake, perceptions of appetite and gastrointestinal symptoms and underlying gastrointestinal mechanisms in healthy women as well as men.

Methodology: In a randomized, double-blind order, eight young women and eight young men (24±5 years, 23±2 kg/m^2) ingested a drink (~450 ml) containing 30 g (120 kcal) or 70 g (280 kcal) whey protein, or an iso-palatable control drink (~2 kcal) followed by regular measurements of perceptions of appetite and gastrointestinal symptoms (visual analog scales), gastric emptying (3D-ultrasonography), concentrations of blood glucose and plasma of insulin, glucagon, ghrelin, CCK, GIP and GLP-1. Three hours after drink consumption, the subjects were presented with a buffet-style meal, from which *ad libitum* energy intake was quantified. Main effects of gender, protein load and their interaction effects were determined using repeated measures ANOVA for energy intake and gastric emptying, and using a repeated measures mixed-effect model including baseline values at each treatment visit as a covariate for perceptions of appetite and gastrointestinal symptoms, blood glucose and plasma hormone concentrations. Post hoc comparisons were adjusted for multiple comparisons using Bonferroni's correction.

Results: Control day energy intake was lower in women than men (791±87 kcal *vs* 1205±109 kcal, mean±SEM, $P = 0.010$). Energy intake at the buffet meal decreased with increasing protein loads ($P = 0.008$). Suppression of *ad libitum* energy intake by whey protein compared to control was less in women than men [mean suppression of energy intake by protein (30 g and 70 g) compared to control: men 206 ± 39 kcal, women 46 ± 54 kcal, $P = 0.032$]. There was an interaction effect of gender by protein load on total energy intake (drink plus meal, $P = 0.046$) and perception of hunger ($P = 0.014$). Hunger was lower after 30g ($P = 0.004$) and 70g ($P < 0.001$) protein intakes compared to control in men, while in women total energy intake was higher after70g protein intake compared to control ($P = 0.033$). Gastric emptying ($P < 0.001$) and glucose, insulin, glucagon, ghrelin, CCK, GIP and GLP-1 concentrations were protein-load dependent. In women, when compared to men, the protein drinks emptied slower from the stomach ($P = 0.021$), which resulted in lower plasma glucagon, CCK, GLP-1 and PYY concentrations and higher blood glucose concentrations (all $P < 0.05$). Energy intake was inversely related to gastric emptying, and insulin, glucagon, CCK, GIP and GLP-1 concentrations, and positively related to ghrelin concentrations (all $P < 0.05$).

Conclusion: The protein load dependent responses of gastric emptying and postprandial gut hormone concentrations were related to energy intake. Suppression of energy intake by whey protein compared to control was less in healthy young women compared to men.

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