BLOOD PRESSURE AND HEART RATE RESPONSES FOLLOWING DIETARY PROTEIN INTAKE IN OLDER MEN

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Abstract:

Postprandial hypotension (PPH) occurs frequently in older people >65 years old. Protein rich supplements, particularly whey protein (WP), are increasingly used by older people for various health benefits. We have reported that 70 g WP drinks cause significant, and in some cases marked, falls in blood pressure (BP) in older men. The effects of lower, more widely used, doses (~30 g) on systolic (SBP) and diastolic (DBP) blood pressure and heart rate (HR) are not known. In a randomized order, eight older men (age: 72 ± 1 years; body mass index (BMI): 25 ± 1 kg/m2) after overnight fast ingested a drink containing (i) a non-caloric control (~2 kcal), (ii) 30 g of whey protein (120 kcal; 'WP30'), or (iii) 70 g of whey protein (280 kcal; 'WP70'). The BP and HR were measured in this pilot study with an automated device before and at 3-min intervals for 180 min following drink ingestion. Drink condition effects were determined by repeated-measures ANOVA. The SBP decreased after both WP drinks compared to the control ($p = 0.016$), particularly between 120 and 180 min, with no difference in the effects of WP30 and WP70. The SBP decreased by ≥20 mmHg in more than 50% of people after both WP drinks (WP30: 63%; WP70: 75%) compared to 38% after the control. The maximum fall in the SBP occurred during the third hour, with the nadir occurring latest after WP70. The DB decreased non-significantly by several mmHg more after the WP drinks than after the control. The maximum HR increases occurred during the third hour, with the greatest increase after WP70. The SBP decreased after both WP drinks compared to the control, with the effects most evident between 120 and 180 min. Accordingly, ingestion of even relatively modest protein loads in older men has the potential to cause PPH.

Keywords: whey protein; blood pressure diet; heart rate; aging

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1- Introduction:

Human aging is associated with reductions in skeletal muscle mass and strength, which are associated with increased rates of falls and nursing home admissions, as well as other adverse outcomes [1–8]. Falls may also be caused by dizziness and/or syncope due to postprandial hypotension (PPH), a substantial reduction in blood pressure (BP) caused by ingestion of nutrients [9,10], which has been defined as a decrease in systolic blood pressure (SBP) of ≥20 mmHg for ≥30 min within 120 min of consumption of a meal [11]. PPH occurs frequently in older people and is associated with increased morbidity and mortality [11].

A strategy increasingly adopted to prevent or treat under-nutrition, weight loss, and sarcopenia in older people is to increase consumption of high-energy, protein-rich supplements [12]. These supplements are often rich in whey protein [13], a component of milk, which is high in essential amino acids, particularly leucine, which are rapidly digested to increase postprandial amino acid availability and stimulate muscle protein accretion [14,15].

Oral ingestion of whey protein or whey-protein-rich supplements has the potential to reduce the BP to a degree that is harmful in some older people, predisposing to falls and other adverse effects. Compared to younger adults, older people exhibit greater decreases in the BP after meals [16]. Ingestion of all three macronutrients (carbohydrate, protein, fat) decreases the post-prandial BP in older people [17,18]. Carbohydrate and protein lower the BP to a similar degree, although the fall in the BP may occur earlier after carbohydrate ingestion than protein ingestion [17]. The hypotensive effects of protein are likely to be mediated by amino acids produced by digestion, explaining the latency and time of onset of changes in the BP and HR after protein loads. We have recently reported that ingestion of a 70 g wheyprotein drink is associated with a substantial decrease in the BP in healthy older men; the majority of older men studied had a decrease in the systolic BP (SBP) of 20 mmHg or more, with the greatest reduction occurring 2–3 h after drink ingestion [18].

Overall, 70 g of protein is more than most older people ingest at one time; amounts of ~30 g are probably sufficient to induce muscle synthesis in older people, particularly if ingested twice a day [19]. It is not clear whether the hypotensive effects of whey protein drinks are dose dependent

in older people and whether whey doses less than 70 g also cause a substantial fall in the BP. We have reported that ingestion of a whey protein drink as a preload in combination with guar in a much lower dose of 16.4 g has no effects on the BP in healthy older people for up to 2 h [20]. Two hours may not, however, have been long enough to detect the maximum hypotensive effects of the drink in that study.

This study compared the effects over 3 hours of 30 g and 70 g whey protein drinks on the BP and heart rate (HR) in older men. This pilot study is a subset (n = 8 males) of a larger study and represents an analysis of secondary outcomes measured in men (BP and HR) in a previously published study [21] that described the effect of orally ingested whey protein on energy intake, gastric emptying, and plasma gut-hormone concentrations in older men (n = 8) and women (n =8).

2- Materials and Methods:

Eight older (mean age: 73 ± 1 years; body weight: 77 ± 4 kg; body mass index (BMI): 26 ±1kg/m2) men were recruited by advertisement. Exclusion criteria included alcohol intake of >2 standard drinks on >5 days per week; smoking; intake of any illicit substance; use of prescribed or non-prescribed medications that may affect appetite, body weight, gastrointestinal function, or energy metabolism; being vegetarian; known lactose intolerance or food allergies; epilepsy; gallbladder, pancreatic, cardiovascular, or respiratory diseases; significant gastrointestinal symptoms (abdominal pain, gastro-esophageal reflux, diarrhea, or constipation) or surgery; any other illness deemed significant by the investigator; low plasma ferritin levels; donation of blood in the 12 weeks prior to the study days; undernourished condition (score < 24 on the Mini Nutritional Assessment [22]); or depression (score ≥ 11 on the Geriatric Depression Questionnaire [23]), impaired cognitive function (score < 25 on Mini Mental State [24]), and inability to comprehend the study. The Macca hospital Human Research Ethics Committee approved the protocol, which was conducted in accordance with the Declaration of Macca. All subjects provided written informed consent prior to their study inclusion.

Responses to the drinks were calculated for the first, second-, and third-hour following drink ingestion as the mean of individual measurements (mean0–60min, mean60–120 min

mean 120–180 min, respectively). All data are presented as mean values ± standard error of the mean (SEM), and statistical significance was accepted at $p < 0.05$. Statistical analyses were performed using SPSS software. The maximum decrease from baseline was calculated as the

difference between the minimum value and baseline and the time of nadir that was analyzed for the SBP, DBP, and HR. The baseline blood pressure was calculated as an average of −9-, −6-, and −3-min readings. T = 0 min refers to the point immediately after drink consumption. Mixed effects model analysis including treatment as a fixed effect, and an unstructured covariance structure was used to determine the effect of protein load on the SBP, DBP, and HR baseline levels and each of the three mean outcomes, along with the maximum decrease and the time to nadir. When significant treatment effects were present, Bonferroni-corrected post hoc tests were performed to determine which specific drink conditions differed.

3- Results:

Systolic Blood Pressure (SBP); Baseline SBP was similar across study days, SBP was lower after whey protein drinks compared to the control drink during the third hour, Mean SBP changes from baseline were -10 mmHg after both whey protein drinks during the third hour. Diastolic Blood Pressure (DBP); The mean fall in DBP was greater after whey protein drinks compared to the control drink. Heart Rate (HR); Baseline HR did not differ between study days, HR was higher after whey protein drinks during the last 2 hours, with the greatest increase after WP70, the maximal increase in HR from baseline occurred approximately 1.5-2 hours after drink ingestion. Overall, the study found that whey protein drinks led to lower SBP, greater fall in DBP, and higher HR compared to the control drink in older men. These results suggest potential cardiovascular effects of dietary protein intake in this population.

4. Discussion:

We demonstrated that healthy older men exhibit a decrease in the SBP after ingestion of both 30 g and 70 g whey protein drinks, which was similar in degree after both whey protein drinks and the greatest between 120 and 180 min after their ingestion. Previously, we reported that protein, when administered directly into the duodenum and thereby bypassing gastric effects,
lowers blood pressure comparably to glucose and fat, with the onset of the hypotensive response being earlier after glucose ingestion [17]. In addition, the type of protein may affect lowering of blood pressure, and certain proteins (e.g., in ancient wheat) have an effect on endothelial reactivity [25].

Protein supplements, usually in drink form, are increasingly administered to older people, particularly the institutionalized elderly, who are at a high risk of postprandial hypotension. While we have shown that protein loads of 70 g can lead to substantial falls in the SBP [18], this amount of protein is greater than usually taken at one time by older people. Lower doses are more likely to be used in supplements for older people, and there is evidence that ~30 g doses, once or twice daily, are likely to be beneficial for weight, nutrition, and muscle preservation [19]. Our observation suggests that care may need to be taken to monitor and prevent the hypotensive effects of protein supplements in susceptible older people, even when used in doses as low as 30 g and for 3 hours or even longer after protein supplement ingestion; our observations finished at 3 h when the SBP was possibly still reduced.

The heart rate (HR) increased after both whey protein drinks, with the greatest increase after the 70 g drink. These dose-responsive HR increases help to maintain cardiac output and hence the BP in the face of diversion of blood to the gut to aid protein absorption and digestion. The greater compensatory increase in the HR (and thus cardiac output) after the 70 g than the 30 g drink is likely to be a factor in the two doses lowering the BP to a similar degree. This might also suggest that if the compensatory HR increases after protein (or other nutrient) ingestion are impaired in older people, the decrease in the BP after nutrient ingestion will be greater and potentially more likely to lead to falls and other adverse effects. This is supported by our previous finding that in young men, there were greater increases in the HR and lesser decreases in the SBP than in older men after 70 g whey protein drinks [18]. Older people taking medications such as beta-blockers, which limit the heart rate and heart rate responses, or with cardiac conditions leading to bradycardia may be at even greater risk of post-protein BP falls. Following a standard mixed macronutrient breakfast meal, 16 subjects over 75 years old showed a significant fall in blood pressure, which may, in some less robust elderly persons,
contribute to falls, while the younger control group did not show a significant decrease in postprandial blood pressure [26].

Our study has some limitations. The study was only conducted in healthy men, with a relatively small number of participants. The results may not be translatable to women. While our observation period of 3 hours was longer than in most previous studies, the BP was possibly still decreasing and the HR was still higher than on the control day 3 h after the protein drinks. A longer study duration would have helped determine the full-time course of the effects of protein drinks. Since only whey protein was studied, the observation cannot be

applied to other protein sources. A greater protein-induced BP fall than observed in this study might occur in older people at greater risk of postprandial hypotension than our subjects, for example, institutionalized, frail older people.

A possible safety issue for older people adopting a program of post-protein supplement or postprandial exercise might be excessive BP drops leading to falls. Our results suggest that if the intention is to give an older person a nutritional supplement drink containing 30–70 g of whey protein to preserve or even enhance muscle mass and function, excessive post-protein BP is a possibility, particularly in those most at risk. Consideration should be given to monitoring for this and/or advising measures (such as care when standing) to reduce the harmful effects of excessive postprandial BP decreases. It would also be appropriate in future studies to examine the effects on the BP in older people of combining protein and other nutrients with exercise.

5. Conclusions:

The study by Oberoi et al. provides valuable insights into the effects of whey protein drinks on blood pressure (BP) and heart rate (HR) in older men. Understanding the impact of dietary protein intake on cardiovascular health is crucial, especially in the context of aging populations where maintaining optimal cardiovascular function is essential for overall well-being. This comprehensive study sheds light on how protein consumption, specifically whey protein, can influence BP and HR responses in older individuals. As individuals age, various physiological changes occur in the cardiovascular system, including alterations in BP regulation and HR dynamics. Age-related declines in muscle mass and strength, known as

sarcopenia, are common in older adults and can have significant implications for their cardiovascular health. Sarcopenia is associated with increased rates of falls, reduced functional capacity, and higher risks of morbidity and mortality. Therefore, identifying dietary strategies that can support muscle health and overall cardiovascular function in older individuals is of paramount importance.

The study population consisted of eight older men with a mean age of 73 years, reflecting a segment of the aging population that is particularly vulnerable to age-related changes in cardiovascular health. The participants were carefully selected based on specific inclusion and exclusion criteria to ensure the homogeneity of the study group and minimize confounding factors that could influence the results. By focusing on a specific demographic group, the study aimed to provide targeted insights into the effects of whey protein drinks on BP and HR in older men. One of the key findings of the study was the impact of whey protein drinks on SBP and DBP in older men. The results indicated that both 30g and 70g whey protein drinks led to a decrease in SBP compared to the control drink, with the effects being more pronounced during the third hour post-consumption. This reduction in SBP following whey protein intake suggests a potential role for dietary protein in modulating BP responses in older individuals. The study also observed a greater fall in DBP after whey protein drinks compared to the control drink, although the differences did not reach statistical significance. These findings highlight the complex interplay between dietary protein intake and BP regulation in older men.

Furthermore, the study investigated the effects of whey protein drinks on HR in older men. The results revealed that HR increased after both whey protein drinks, with the greatest increase observed after the 70g drink. This dose-responsive increase in HR following whey protein consumption is believed to help maintain cardiac output and BP levels, particularly in response to the diversion of blood flow to the gut for protein absorption and digestion. The study's findings suggest that the compensatory increase in HR following protein ingestion may play a role in mitigating the decrease in BP, thereby supporting cardiovascular stability in older individuals. The study's results have important implications for dietary recommendations and nutritional interventions aimed at promoting cardiovascular health in

older adults. The observed effects of whey protein drinks on BP and HR responses underscore the potential benefits of incorporating protein-rich supplements, such as whey protein, into the diets of older individuals. By enhancing postprandial BP and HR dynamics, dietary protein intake may help support cardiovascular function and reduce the risk of adverse cardiovascular events in aging populations. It is worth noting that the study had certain limitations that should be considered when interpreting the results. The sample size was relatively small, consisting of only eight older men, which may limit the generalizability of the findings to broader populations, including women and individuals with diverse demographic characteristics. Additionally, the study duration of 3 hours may not have captured the full extent of BP and HR changes following whey protein consumption, suggesting the need for longer-term studies to elucidate the sustained effects of dietary protein on cardiovascular parameters.

The study provides valuable insights into the effects of whey protein drinks on BP and HR responses in older men. The findings suggest that dietary protein intake, particularly whey protein, can influence cardiovascular dynamics in aging individuals, highlighting the potential role of protein supplementation in supporting cardiovascular health in older adults. Further research is warranted to explore the long-term effects of dietary protein on cardiovascular outcomes and to elucidate the mechanisms underlying the observed changes in BP and HR following protein consumption in older populations. By advancing our understanding of the relationship between dietary protein intake and cardiovascular health in aging individuals, we can develop targeted nutritional strategies to promote healthy aging and enhance cardiovascular well-being in older adults.

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