

A Pilot Study of the Effects of Collagen vs. Whey Protein Supplementation on Delayed Onset Muscle Soreness in Healthy Individuals

Original Research

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Abstract

Introduction: Delayed onset muscle soreness (DOMS) is a common condition characterized by muscle stiffness, pain, and inflammation following intense or unaccustomed exercise. Despite its prevalence, the underlying mechanisms of DOMS remain unclear. This study aimed to investigate the effects of collagen supplementation on tissue repair and pain associated with DOMS in exercise-trained individuals.

Methods: Fourteen exercise-trained men (n=7) and women (n=7) were enrolled in a randomized, counterbalanced, crossover trial. Participants were assigned to either a whey protein group (n=8) or a collagen protein group (n=6). Each participant consumed 40g of their respective protein supplement daily for four consecutive days. Peak soreness was assessed using self-reported ratings and algometer measurements. Statistical analysis included independent samples t-tests and Levene's test for equality of variances.

Results: The analysis revealed no significant difference in peak soreness between the whey protein and collagen protein groups at the 24-hour time point ($t(12) = 1.33$, $p = 0.208$). Both groups experienced a decrease in peak soreness over the 24-hour period, but the reduction was not statistically different between the groups. No significant differences were observed in other variables measured.

Conclusions: These findings suggest that collagen protein supplementation did not significantly reduce peak soreness associated with DOMS compared to whey protein supplementation in exercise-trained individuals. While collagen supplementation has shown potential benefits in tissue repair and joint health, further research is needed to explore its specific effects on DOMS. Larger studies with different dosages and participant populations are warranted to obtain a more comprehensive understanding of collagen's impact on muscle soreness and tissue repair.

Key Words: Delayed onset muscle soreness, collagen supplementation, whey protein, exercise-trained individuals, pain, tissue repair.

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Introduction

Delayed onset muscle soreness (DOMS) occurs when a muscle is experiencing stiffness and inflammation from an external load with symptoms ranging from tenderness to severely debilitating pain¹. The symptoms typically intensify



the first 24 hours after exercise and peak around 24 to 72 hours². DOMS related symptoms occur from the eccentric movement of an unfamiliar activity as opposed to the concentric movement³. However, according to current literature, the underlying mechanism of DOMS is not completely understood, but it has been identified that the microtrauma to the muscle fibers, which then leads to inflammation plays a critical role^{1,3}. Additionally, the intensity and duration of the eccentric activity also play an important role in the extent of symptoms associated with delayed onset muscle soreness^{4,5}. When an individual performs an activity at an unfamiliar intensity or duration, the potential of the muscle experiencing DOMS becomes more likely. Various treatment strategies help alleviate the pain associated with DOMS, which can range from nutritional to physical therapeutic methods. A few of the treatment strategies include nonsteroidal anti-inflammatory drugs, massage, heat therapy, cold therapy, stretching, and transcutaneous electrical nerve stimulation (TENS)^{3,4,6,7}.

Many nutritional or supplemental strategies for reducing pain and soreness levels from delayed onset muscle have been investigated. Curcumin, an extract from the root of the *Curcuma* plant, is known for its anti-inflammatory properties in sports nutrition⁸. In addition to curcumin, protein consumption is essential for muscle recovery and growth. Nieman et al. investigated the effects of whey and pea protein supplementation (0.9 g protein/kg divided into three doses/day) on post-eccentric exercise damage⁹. Their results showed that whey and pea protein, compared to water supplementation had no significant effects on post-exercise DOMS. It should be noted that 0.9 g protein/kg is significantly lower than the protein recommendation for athletes, which could have played a role in the results. According to the International Society of Sports Nutrition, it is recommended that protein consumption should fall between a range of 1.4-2.0 g protein/kg body weight/day for exercising individuals¹⁰.

Collagen is an abundant structural protein in all animals¹¹. There are around 28 different types of collagens that have been identified¹². The most studied and abundant family of collagens is represented by the fibril-forming collagens. Specifically, fibril-forming collagen type I is the most abundant and studied collagen¹²⁻¹⁴. Collagen type I tissue distribution is mainly in the bone, dermis, tendon, ligaments, and cornea. Collagen type I serves important mechanical functions in the body¹⁵. Collagen type I mainly contributes to the maintenance of the structural integrity of tissues and organs. Collagen type I also serves as a major functional backbone of both bone and cartilage structures. Additionally, collagen type I plays an important role in the local storage and delivery of growth factors and cytokines, therefore vital during organ development, wound healing, and tissue repair¹⁶⁻¹⁸.

Collagen supplementation is widely known for its potential positive effects on skin health, bone health, and tissue repair^{15,16,19}. Specifically, collagen hydrolysate, a dietary supplement made from connective tissue from porcine sources such as bone, is shown to increase mobility, decrease pain, and reduce dependency on analgesics²⁰. Additionally, Clark et al conducted a study consisting of supplementation of 10 g/day of collagen hydrolysate with individuals who suffer from joint pain due to strenuous effort and physical exercise. In their investigation, the results showed that oral collagen hydrolysate can potentially improve joint health and reduce pain symptoms associated with strenuous athletic activity²¹. To date, there are no investigations on the effects of collagen supplementation on DOMS. Collagen supplementation is widely known for its health benefits on tissue repair and joint pain. Many nutritional interventions have investigated the effects of reducing pain from activity resulting in DOMS, but not with collagen supplementation. The purpose of this investigation is to gain a better understanding of collagen supplementation on tissue repair while exploring possible treatment for pain associated with delayed onset muscle soreness.

Scientific Methods

Participants

A total of 14 healthy men (n=7) and women (n=7) volunteered for this randomized, counterbalanced, crossover trial. All participants were exercise-trained individuals between the ages of 18 and 40 years of age. Participants reported to the lab for four consecutive days to participate in testing. The Institutional Review Board for Nova Southeastern University approved all procedures involving human subjects (IRB #2021-627-NSU). Prior to participation, written informed consent was obtained from all participants. Exercise history was obtained through a questionnaire. Participants' exercise history was determined by reporting their average weekly resistance training, aerobic training exercise times, and other forms of exercise.

Protocol

Participants came to the laboratory on two (Baseline and 24-hr testing) consecutive occasions. Participants were randomly assigned into two groups: whey (n=8) or collagen (n=6). The following was assessed on each of the two



laboratory visits: resting blood pressure, resting heart rate, self-report rating of soreness or discomfort, self-reported rating of stiffness, self-reported rating of interferences on daily activities and physical activities, algometer assessment of muscle soreness, goniometric assessment, muscle circumferences, compliance with the taking the supplementation. To ensure accuracy, the same researcher assessed a participant on day one and two.

Supplement

Participants were randomly assigned to either whey or collagen protein groups. Each participant was given a total of four 40g of either whey or collagen protein to consume for the 2-day study. They were instructed to consume 40g per day for two consecutive days. To ensure and track every participant's supplement intake, they were asked to report their compliance each day via a questionnaire. This study used 40g of either protein dose, which is a common dose examined in literature ²².

Body Composition

A multi-frequency bioelectrical impedance device (InBody® 270) was used to assess body composition (body mass, fat mass, lean body mass, body fat percentage, and total body water in liters). Each participant was instructed to arrive fasted for at least three hours. Participants stood on the device platform with bare feet on the electrodes, then were instructed by the device to grasp the handles (which contain additional electrodes on the thumb and fingers) while keeping their arms straight and their arms horizontally adducted approximately 30 degrees. This process takes about one minute. Baseline body composition was only assessed during this study.

Protocol To Induce Muscle Soreness

The study will include one exercise visit (day one – baseline testing) plus one follow-up visit (day two – 24hr testing). At the exercise visit, the research participant had their study eligibility confirmed, completed a pre-exercise assessment, and underwent a protocol to induce muscle soreness using eccentric contraction exercise from the non-dominant arm, so that their ordinary life would not be impeded. One repetition maximum (1RM) method, the maximum amount of weight one can lift in a single repetition for a given exercise was used in order to induce delayed onset muscle soreness. Participants sat in front of a treatment table with a flexed shoulder joint at 45 degrees. They placed their elbow on the pad of the table, held a dumbbell weighing 60% of the 1RM, maintained it for one second at 90 degrees, and lowered it slowly for three seconds. After their elbow was completely extended, the researcher put their arm in a 90-degree flexion position. They completed 1 set of 75 repetitions. Immediately following the completion of the DOMS protocol, they completed ratings of soreness, discomfort, and additional indices of exertion along with morphological measurements of the non-dominant arm.

Protocol to Measure Muscle Circumference and Range of Motion

Using an instrument known as a goniometer, the researchers measured the participant's relaxed elbow angle, active range of motion, and passive range of motion. The participant stood during each elbow angle measurement. The participants stood and had their elbow relaxed while the researcher took the relaxed elbow angle goniometer measurement. For the active range of motion, the participants were asked to flex their elbow until there was no more range of motion. For the passive range of motion, the participant was asked to flex their elbow and hold their forearm which is being measured with the opposite arm. To measure the muscle circumference, the researcher used a tape measure. These assessments took about five to ten minutes to do.

Muscle Algometer Protocol

An algometer is a held-hand device that measures the pressure and/or force eliciting a pressure-pain threshold²³. The researcher pressed slowly and systematically the blunt end of the instrument into the distal portion of the participant's elbow flexor muscles (approximately one inch from the elbow area) to target the bicep muscle. The researcher recorded the pressure denoted on the instrument in which the participant felt pain that is no longer tolerable. This assessment was conducted each day the participant visited the lab and took about two to three minutes to conduct.

Assessment of Self-Reported Ratings of Soreness, Stiffness, and Discomfort

Participants completed a questionnaire each time they visited the lab to report their level of soreness, stiffness, and/or discomfort via a numeric rating scale that ranges from zero (0) indicating none, five (5) would indicate moderate, and ten (10) would indicate severe. Participants reported their interferences on daily activities and physical activities using the same numeric rating scale. These questionnaires took approximately five to ten minutes to complete.

Statistical Analysis

All data are presented as the mean $\pm$ SD. Intellectus Statistics statistical software was used to perform all statistical analyses. An independent samples t-test was performed to determine whether statistically significant differences ($p < 0.05$) occurred between the whey protein group and collagen protein group.

Results

The participants' characteristics are shown in Table 1. A two-tailed independent samples t -test was conducted to examine whether the mean of peak soreness was significantly different between the Whey and Collagen categories of Treatment. Levene's test was conducted to assess whether the variance of peak soreness was equal between the categories of Treatment. The result of Levene's test for peak Soreness was not significant based on an alpha value of .05, $F(1, 12) = 0.07, p = .789$. This result suggests it is possible that the variance of peak Soreness is equal for each category of Treatment, indicating the assumption of homogeneity of variance was met. The result of the two-tailed independent samples t -test was not significant based on an alpha value of .05, $t(12) = 1.33, p = .208$, indicating the null hypothesis cannot be rejected. This finding suggests the mean of peak soreness was not significantly different between the Whey and Collagen categories of treatment during the 24-hour time point. No significant differences existed between the other variables as presented in Table 1. The results are presented in Table 2. A bar plot of the means is presented in Figure 2.

Table 1. Physical Characteristics of the Research Participants

	Female	Male
Age (yrs)	23.1 $\pm$ 4	23.4 $\pm$ 4.4
Height (cm)	163.5 $\pm$ 13	177.5 $\pm$ 3.2
Body Mass (kg)	58 $\pm$ 8	85.6 $\pm$ 16
Lean Body Mass (kg)	45.2 $\pm$ 9	71.5 $\pm$ 8.2
Fat Mass (kg)	12.8 $\pm$ 6	14 $\pm$ 9
% Body Fat	22.5 $\pm$ 6	15.3 $\pm$ 8.6
Body Mass Index (kg$\cdot$m⁻²)	21.7 $\pm$ 1.2	27.2 $\pm$ 5.4
Total Body Water (L)	33.1 $\pm$ 6.6	52.4 $\pm$ 6

The data are presented as the mean $\pm$ SD.

Table 2. Change In Arm Circumference, Pressure Threshold, and Perceived Peak Soreness Between Baseline and 24-hours.

	Whey	Collagen	P-value
Change in Arm Circumference (cm)			
24 hours	0.41 $\pm$ 1.11	2.10 $\pm$ 2.14	0.274
Change in Pressure Threshold (N)			
24 hours	-11.3 $\pm$ 10.41	-23.41 $\pm$ 22.21	0.430
Change in Perceived Peak Soreness			
24 hours	3.12 $\pm$ 2.10	3.21 $\pm$ 1.70	0.208

The data are presented as the mean $\pm$ SD. Legend: CM = Centimeters; N = Newtons

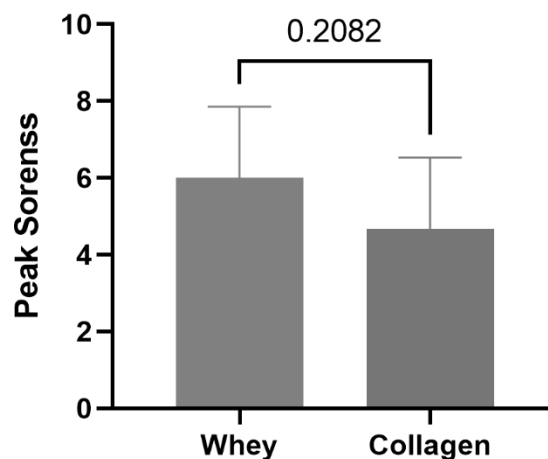


Figure 1. Self-reported peak soreness for the whey protein and collagen protein groups. There was no significant difference in peak soreness between whey and collagen groups.

Discussion

The present study aimed to investigate the effects of collagen vs. whey supplementation on DOMS in healthy individuals. The study compared the effects of whey versus collagen protein supplementation on indices of skeletal muscle damage in exercise-trained individuals. The results of the study did not show a significant difference in peak soreness (or any other variables) between the whey protein and collagen protein groups. Both groups exhibited a decrease in peak soreness over the 24-hour period, with no statistically significant variation between them. These findings suggest that neither whey protein nor collagen protein supplementation had a substantial impact on reducing DOMS-associated pain in the studied population.

Previous research has investigated various nutritional interventions for alleviating pain and soreness associated with DOMS. For instance, Nieman et al. explored the effects of whey and pea protein supplementation on post-eccentric exercise damage and reported no significant effects on DOMS⁹. However, the protein dosage used in that study (0.9 g protein/kg divided into three doses/day) which if it is the only daily protein source, is notably lower than the recommended range for athletes in the ISSN's position stand (1.4-2.0 g protein/kg)¹⁰. Neiman's study did not measure physical activity or food intake; it is possible that the suboptimal protein dosage could have influenced the outcomes.

Collagen supplementation has gained attention for its potential benefits in tissue repair and joint health²⁴. Studies have shown positive effects on joint pain reduction and improved joint health with collagen hydrolysate supplementation^{6,25}. However, there is limited research on the effects of collagen supplementation specifically on DOMS. The present study aimed to address this gap in the literature but did not find significant differences in peak soreness between the collagen protein group and the whey protein group.

It is worth noting that the sample size in this study was relatively small, with a total of 14 participants. Larger sample sizes may be needed to detect significant differences in future investigations. Future studies could explore different dosages, treatment durations, participant populations, and sex differences to obtain a more comprehensive understanding of collagen's impact on DOMS. A DOMS study by Evans et al., observed the differences in pain perception between sex, this could also help us further understand if any collagen has any impact on males vs. females²⁶.

In conclusion, the current study did not find a significant difference in the delta score of peak soreness, pain threshold, or arm circumference between the collagen protein and whey protein groups in exercise-trained individuals. Although collagen supplementation has been associated with various health benefits, including joint pain reduction and tissue repair, further research is warranted to elucidate its specific effects on DOMS. The findings contribute to the existing knowledge on nutritional interventions for DOMS, highlighting the need for larger studies and a deeper exploration of collagen supplementation in the context of muscle soreness and tissue repair.



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References

- Cheung K, Hume PA, Maxwell L. Delayed onset muscle soreness. *Sports medicine*. 2003;33(2):145-164.
- Kanda K, Sugama K, Hayashida H, et al. Eccentric exercise-induced delayed-onset muscle soreness and changes in markers of muscle damage and inflammation. *Exercise immunology review*. 2013;19
- Cleak M, Eston R. Delayed onset muscle soreness: mechanisms and management. *Journal of sports sciences*. 1992;10(4):325-341.
- Connolly DA, Sayers SE, McHugh MP. Treatment and prevention of delayed onset muscle soreness. *The Journal of Strength & Conditioning Research*. 2003;17(1):197-208.
- Lewis PB, Ruby D, Bush-Joseph CA. Muscle soreness and delayed-onset muscle soreness. *Clinics in sports medicine*. 2012;31(2):255-262.
- Kviatkovsky SA, Hickner RC, Ormsbee MJ. Collagen peptide supplementation for pain and function: is it effective? *Current opinion in clinical nutrition and metabolic care*. 2022;25(6):401-406.
- Wang Y, Li S, Zhang Y, et al. Heat and cold therapy reduce pain in patients with delayed onset muscle soreness: A systematic review and meta-analysis of 32 randomized controlled trials. *Physical Therapy in Sport*. 2021;48:177-187.
- Nicol LM, Rowlands DS, Fazakerly R, Kellett J. Curcumin supplementation likely attenuates delayed onset muscle soreness (DOMS). *European journal of applied physiology*. 2015;115:1769-1777.
- Nieman DC, Zwetsloot KA, Simonson AJ, et al. Effects of whey and pea protein supplementation on post-eccentric exercise muscle damage: a randomized trial. *Nutrients*. 2020;12(8):2382.
- Jäger R, Kerksick CM, Campbell BI, et al. International society of sports nutrition position stand: protein and exercise. *Journal of the International Society of Sports Nutrition*. 2017;14(1):20.
- Shoulders MD, Raines RT. Collagen structure and stability. *Annual review of biochemistry*. 2009;78:929-958.
- Ricard-Blum S. The collagen family. *Cold Spring Harbor perspectives in biology*. 2011;3(1):a004978.
- Gordon MK, Hahn RA. Collagens. *Cell and tissue research*. 2010;339(1):247-257.
- Maynes R. *Structure and function of collagen types*. Elsevier; 2012.
- Naomi R, Ridzuan PM, Bahari H. Current insights into collagen type I. *Polymers*. 2021;13(16):2642.
- Clifford T, Ventress M, Allerton DM, et al. The effects of collagen peptides on muscle damage, inflammation and bone turnover following exercise: a randomized, controlled trial. *Amino Acids*. 2019;51:691-704.
- Inoue Y, Itoh H, Aoki M, et al. Accelerating effect of soy peptides containing collagen peptides on type I and III collagen levels in rat skin. *Bioscience, biotechnology, and biochemistry*. 2012;76(8):1549-1551.
- Schwarz D, Lipoldová M, Reinecke H, Sohrabi Y. Targeting inflammation with collagen. *Clinical and Translational Medicine*. 2022;12(5):e831.
- Khatri M, Naughton RJ, Clifford T, Harper LD, Corr L. The effects of collagen peptide supplementation on body composition, collagen synthesis, and recovery from joint injury and exercise: a systematic review. *Amino Acids*. 2021;53(10):1493-1506.
- León-López A, Morales-Peñaloza A, Martínez-Juárez VM, Vargas-Torres A, Zeugolis DI, Aguirre-Álvarez G. Hydrolyzed collagen—Sources and applications. *Molecules*. 2019;24(22):4031.
- Clark KL, Sebastianelli W, Flechsenhar KR, et al. 24-Week study on the use of collagen hydrolysate as a dietary supplement in athletes with activity-related joint pain. *Current medical research and opinion*. 2008;24(5):1485-1496.
- Tipton KD, Ferrando AA, Phillips SM, Doyle Jr D, Wolfe RR. Postexercise net protein synthesis in human muscle from orally administered amino acids. *American Journal of Physiology-Endocrinology And Metabolism*. 1999;276(4):E628-E634.
- Kinser AM, Sands WA, Stone MH. Reliability and validity of a pressure algometer. *The Journal of Strength & Conditioning Research*. 2009;23(1):312-314.
- Kviatkovsky S. Impact of Collagen Peptides Supplementation on Pain, Function, and Markers of Bone and Connective Tissue Turnover in Active Adults. 2022;



25. Kviatkovsky SA, Hickner RC, Cabre HE, Small SD, Ormsbee MJ. Collagen peptides supplementation improves function, pain, and physical and mental outcomes in active adults. *Journal of the International Society of Sports Nutrition*. 2023;20(1):2243252.
26. Evans C, Curtis J, Mekhail V, et al. Battle of the Sexes: Differences in Pain Perception Post-Eccentric Exercise. *Journal of Exercise Physiology Online*. 2022;25(3)