Collagen: A Practical Update for Sports Medicine Providers

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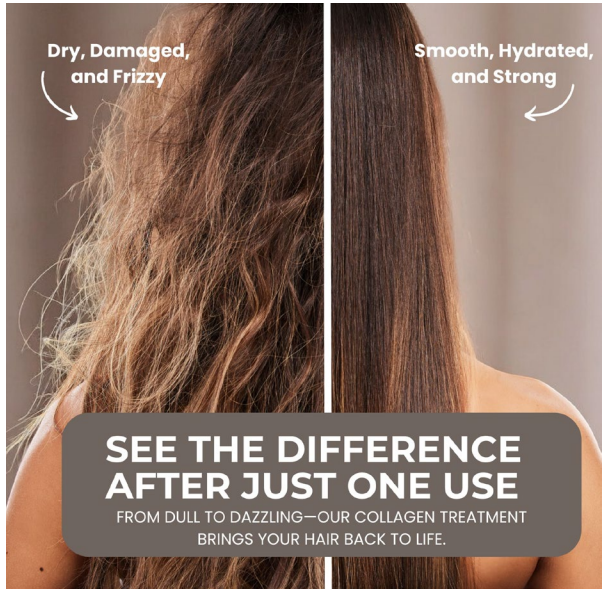
#1 PHARMACIST RECOMMENDED
Nature Made
GUMMIES
Hair•Skin•Nails‡
‡Biotin supports healthy hair, skin & nails†
Dietary Supplement
90 GUMMIES


Dry, Damaged, and Frizzy
Smooth, Hydrated, and Strong
SEE THE DIFFERENCE AFTER JUST ONE USE
FROM DULL TO DAZZLING—OUR COLLAGEN TREATMENT BRINGS YOUR HAIR BACK TO LIFE.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Outline

What is collagen?

Protein metabolism review

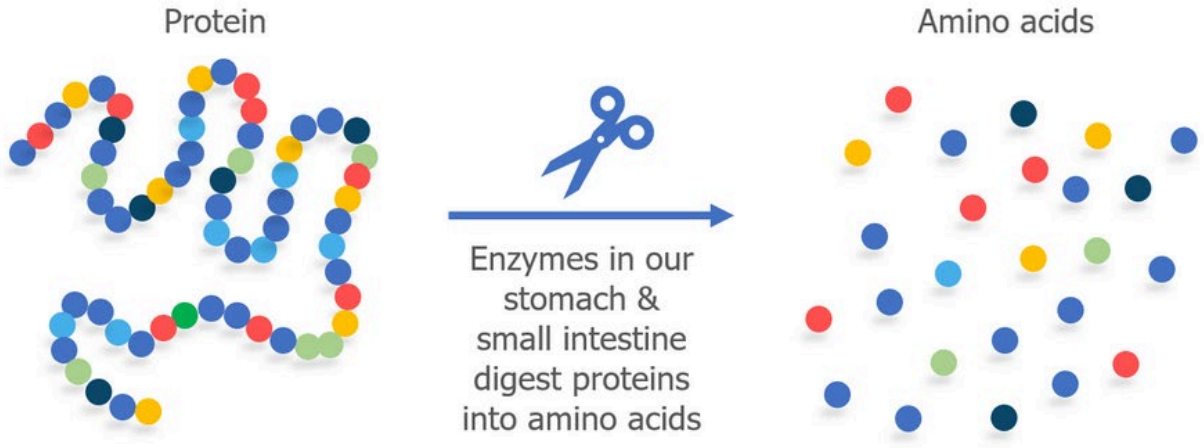
Potential therapeutic uses of collagen

Practical applications

Collagen

- The most abundant protein in the human body
  - 28 types identified
  - Type I – skin, bone, teeth, tendons, ligaments, vascular ligature and organs
  - Type II – cartilages
  - Tyle III – skin and blood vessels

Protein Digestion and Amino Acids



Essential	Nonessential
Histidine	Alanine
Isoleucine	Arginine
Leucine	Asparagine
Lysine	Aspartate
Methionine	Cysteine
Phenylalanine	Glutamate
Threonine	Glutamine
Tryptophan	**Glycine**
Valine	**Proline**
	Serine
	Tyrosine

Collagen's Unique Amino Acid Content

- Collagen is rich in glycine, proline and hydroxyproline
    - Collagen is 33% glycine
    - Optimum Nutrition whey is 1.5% glycine
    - Chicken Breast 1.84% glycine

More of the collagen-derived amino acids = more endogenous collagen synthesis?

Collagen’s Big Break

Randomized Controlled Trial > Am J Clin Nutr. 2017 Jan;105(1):136-143.
doi: 10.3945/ajcn.116.138594. Epub 2016 Nov 16.

Vitamin C–enriched gelatin supplementation before intermittent activity augments collagen synthesis

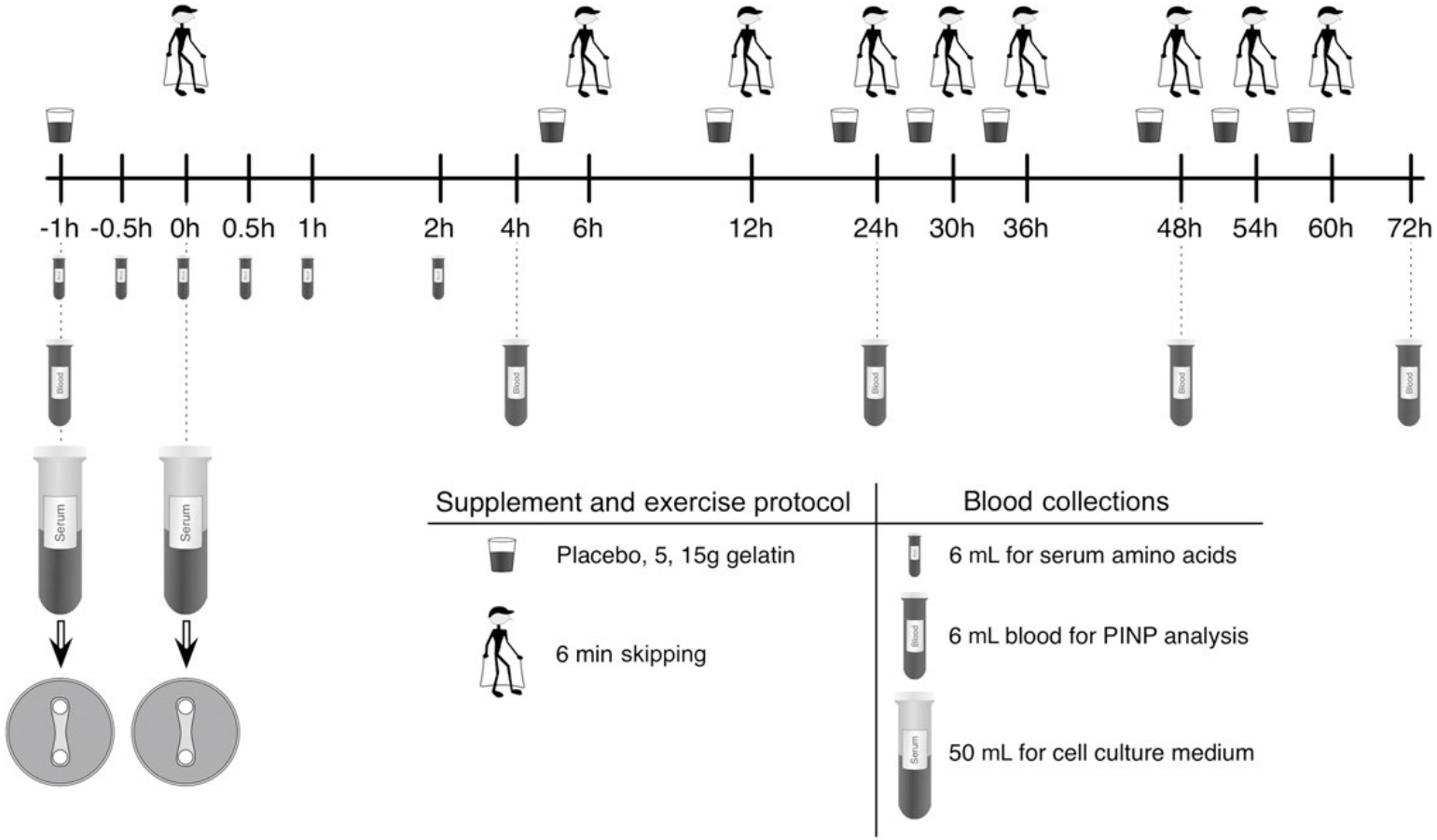
Gregory Shaw [1], Ann Lee-Barthel [2], Megan Lr Ross [1 3], Bing Wang [4], Keith Baar [5 6 7]

Affiliations + expand

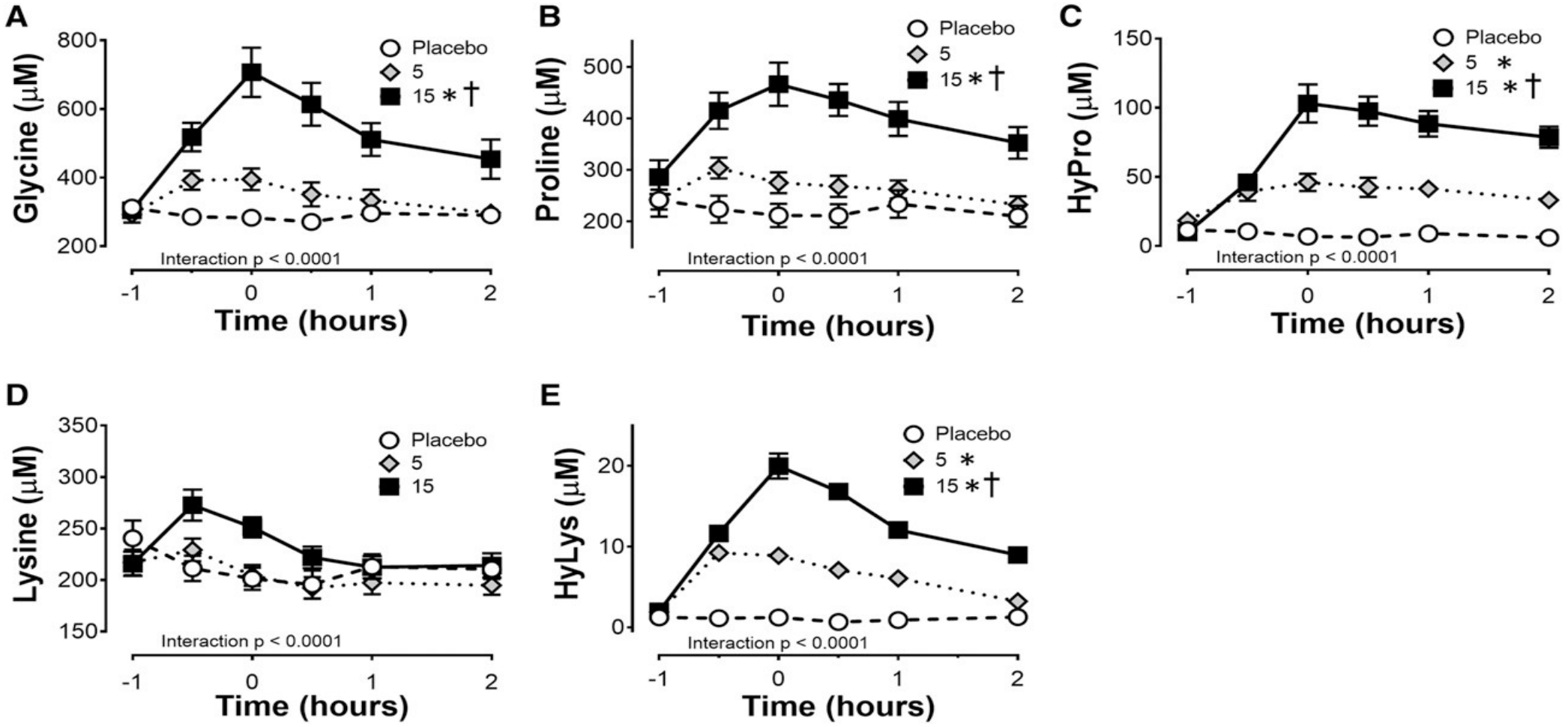
PMID: 27852613 PMCID: PMC5183725 DOI: 10.3945/ajcn.116.138594

Methods

- Multi-part Study
- 8 males
  - Gelatin Concentration: 0, 5, or 15 g mixed is 48 mg Vitamin C
  - Serum Amino Acid Content
  - P1NP (marker of bone collagen synthesis)
- Engineered ligament
  - CSA
  - Collagen content

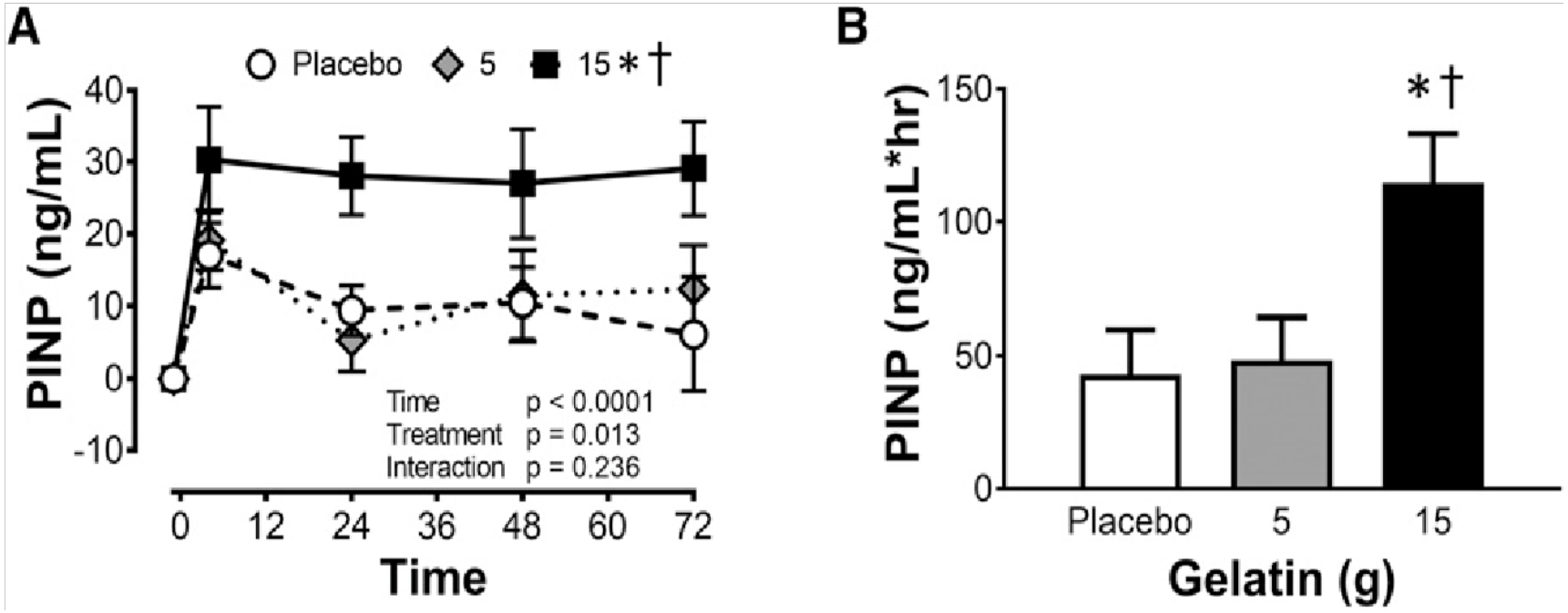


Amino Acids Found in Collagen Increased in a Dose-Dependent Manner

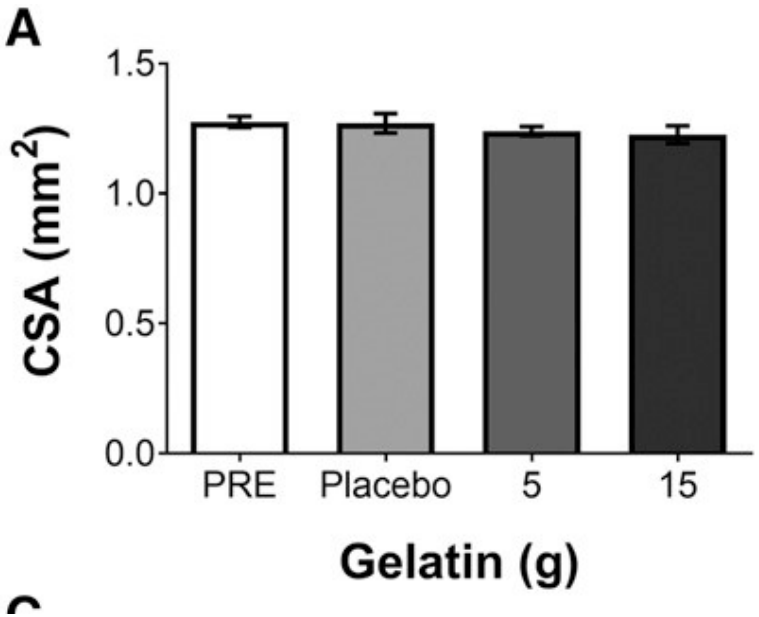


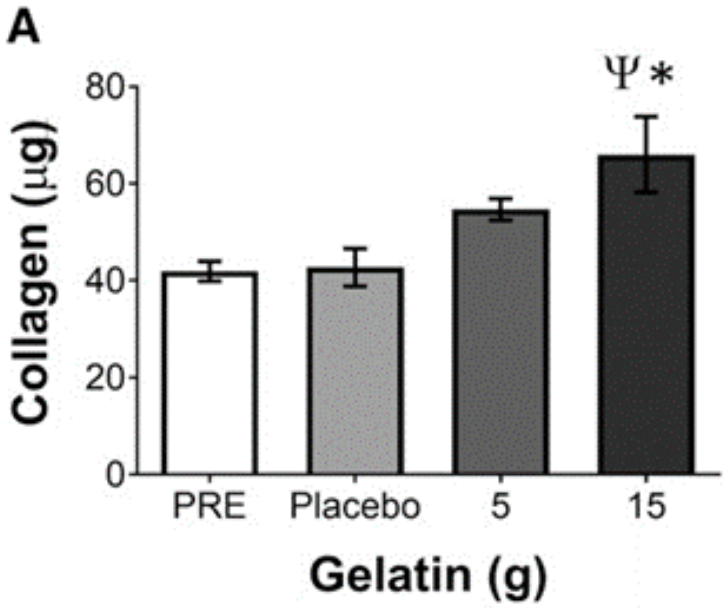
Effect of 72 Hour Supplementation In Vivo

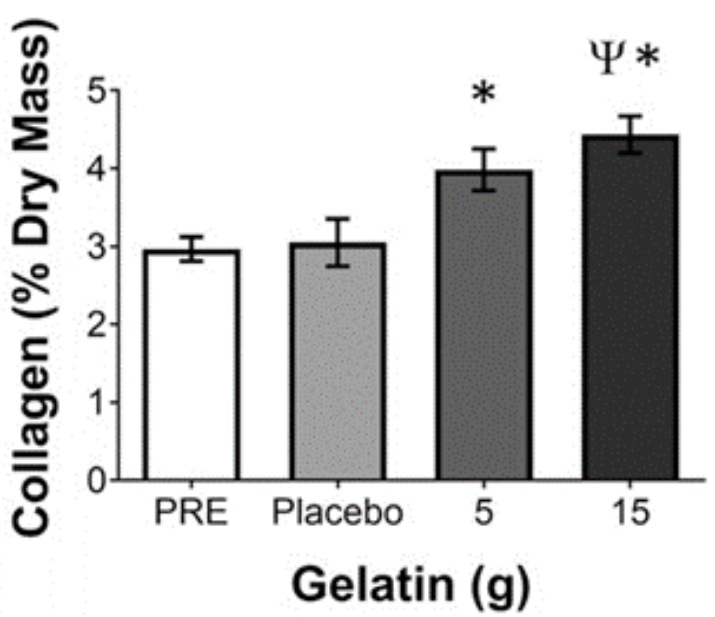
- Sustained elevation of P1NP during entire trial for 15g Group



Collagen increased in a dose dependent manner in engineered ligaments







Conclusions

- Supplementation with gelatin and vitamin C resulted in a dose dependent response of increased serum AA and increased PINP
- Engineered ligaments showed increased collagen content and crosslinking

Exercise itself is a stimulus of these changes too

- More research is needed
  - In vivo, is the increased AA leading to increased collagen synthesis in exercised tissue?
  - Does this translate to a larger sample size?
  - Is this supplementation helpful to health or performance?

Challenges with Collagen Research

- Relatively new – limited high-quality studies have been published
- Meta-analyses of data indicates limited outcomes with robust evidence to support use

- **Many studies compare collagen to a non-protein containing placebo such as maltodextrin**
- Many studies are indirectly assessing collagen synthesis (ex. P1NP) – unknown if there is a true benefit to the working joints/tendons

Potential Therapeutic Uses of Collagen

(Australian Institute of Sport, 2021)

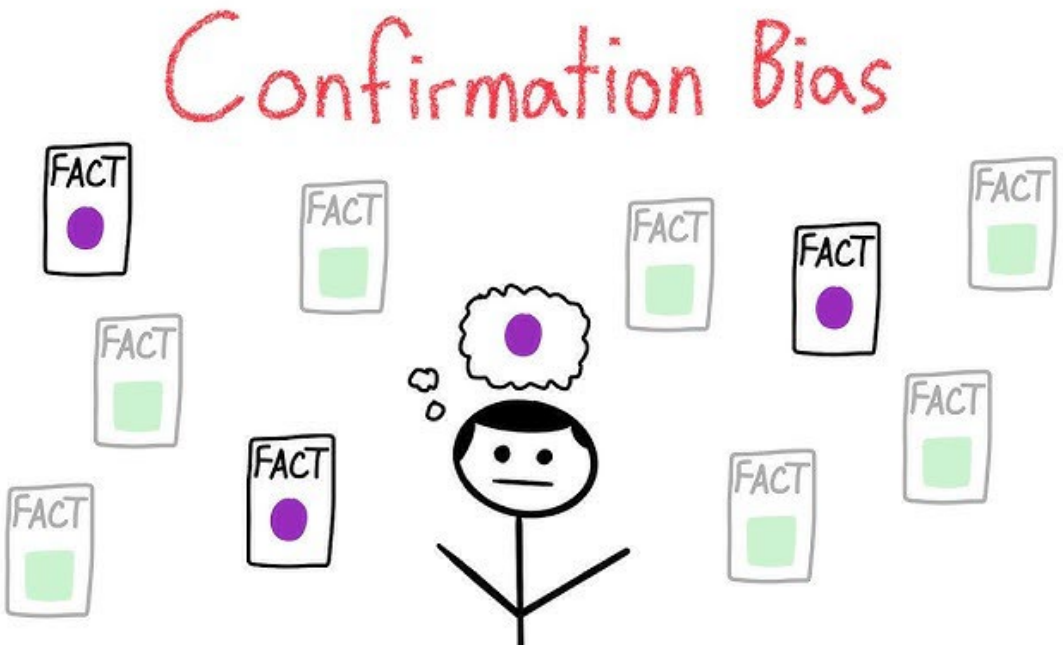
Reduce tendon and joint-related pain

Injury reduction through increased tendon and ligament cross sectional area and thickness

Treatment or prevention of degenerative diseases like osteoarthritis

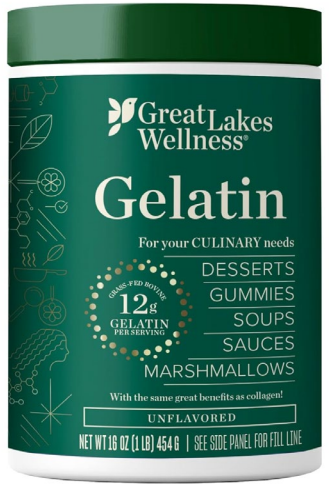
Assist in bone strength and reduce fracture risk

Improve muscle recovery



Literature Review

Reducing Tendon Related Pain



21 year old, NBA athlete with hx of patellar tendinopathy x 5 years

21 month intervention

15 g collagen (Great Lakes unflavored beef gelatin) mixed with 16 oz orange juice (~225 mg Vit C) taken 1 hour prior to stress relaxation loading rehab program 2x/wk

Case Reports > Int J Sport Nutr Exerc Metab. 2019 Jul 1;29(4):453–457.
doi: 10.1123/ijsnem.2018-0231.

Stress Relaxation and Targeted Nutrition to Treat Patellar Tendinopathy

Keith Baar [1]

Affiliations + expand

PMID: 30299199 DOI: 10.1123/ijsnem.2018-0231

Reducing Tendon Related Pain - Results

After 18 months, a “blinded” orthopedic surgeon declared the tendon normal

Tendon thickness at insertion point reduced by 25%

Tendon thickness increased at mid-point by 10%

Self-reported pain and tenderness decreased; at 18 months the athlete considered himself pain free

Reducing Joint Pain

Randomized Controlled Trial > Curr Med Res Opin. 2008 May;24(5):1485-96.
doi: 10.1185/030079908x291967. Epub 2008 Apr 15.

24-Week study on the use of collagen hydrolysate as a dietary supplement in athletes with activity-related joint pain

Kristine L Clark [1], Wayne Sebastianelli, Klaus R Flechsenhar, Douglas F Aukermann, Felix Meza, Roberta L Millard, John R Deitch, Paul S Sherbondy, Ann Albert

Affiliations + expand

PMID: 18416885 DOI: 10.1185/030079908x291967

- 97 Varsity/club team athletes at Penn State
- Given 25 mL with 10 g collagen or placebo for 24 weeks
- Improvements seen in:
  - Joint pain at rest assessed by physician
  - Assessed by participants
    - Joint pain when walking
    - Joint pain when standing
    - Joint pain at rest
    - Joint pain when carrying objects
    - Joint pain when lifting

Prevention of Injury

› Front Physiol. 2023 Jan 26:14:1089971. doi: 10.3389/fphys.2023.1089971. eCollection 2023.

Collagen supplementation augments changes in patellar tendon properties in female soccer players

Joonsung Lee [1], Josh E Bridge [1], David R Clark [1], Claire E Stewart [1], Robert M Erskine [1 2]

Affiliations + expand

PMID: 36776971 PMCID: PMC9910607 DOI: 10.3389/fphys.2023.1089971

- 17 elite youth soccer players
- 30 g collagen with 500 mg Vit C after training 3x/wk for 10 week season

- No changes in knee MIVC or vastus lateralis muscle thickness
- No changes in patellar tendon cross sectional area
- **Patellar tendon stiffness and Youngs' modulus both increased significantly more in the collagen group than the placebo**

Bone Strength and Fracture Risk

▸ Nutrients. 2018 Jan 16;10(1):97. doi: 10.3390/nu10010097

Specific Collagen Peptides Improve Bone Mineral Density and Bone Markers in Postmenopausal Women—A Randomized Controlled Study

Daniel König [1,*], Steffen Oesser [2], Stephan Scharla [3], Denise Zdzieblik [1], Albert Gollhofer [1]

- 131 healthy post-menopausal women
- 5 g collagen peptides or 5 g maltodextrin for a year
- Encouraged to take 500-800 mg Ca and 400-800 IU Vit D, but this was not controlled
- 4 day food logs at baseline and conclusion of study showed similar intakes between the groups; inadequate dietary vitamin D, protein and fat exceeding recommendations

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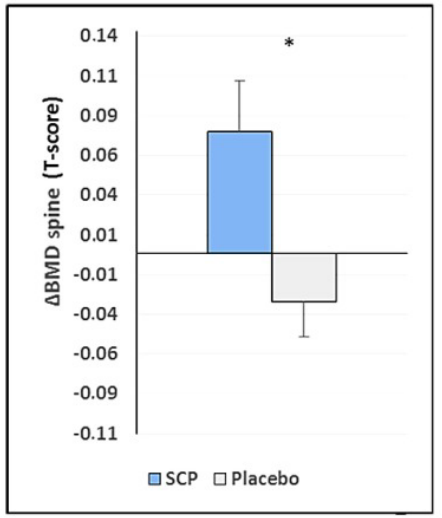
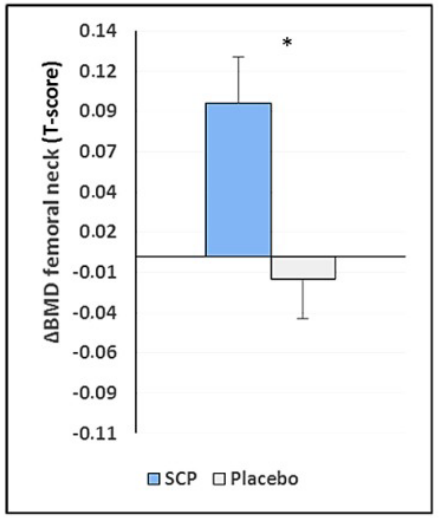
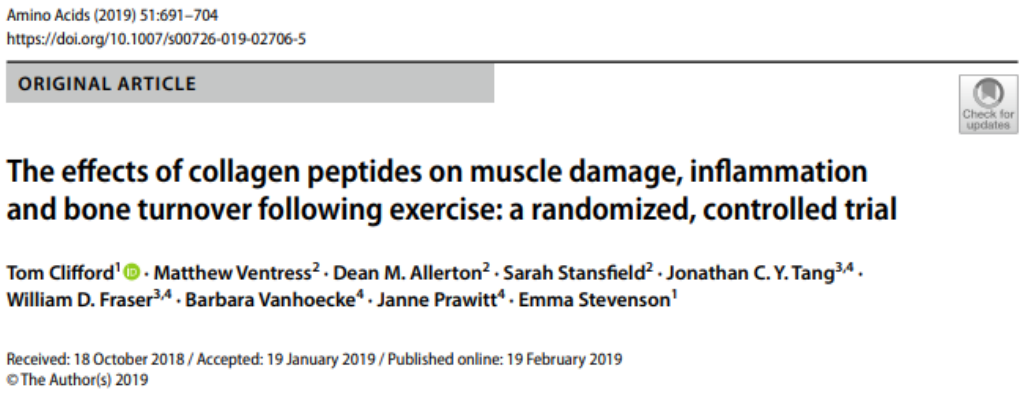




	Group	n	$\bar{X}0 \pm SD_0$	$\bar{X}12 \pm SD_{12}$	p-Value *
P1NP [ng/mL]	**SCP**	**66**	**33.34 ± 24.70**	**37.22 ± 27.70**	**0.007**
	Placebo	65	38.74 ± 27.00	40.6 ± 28.35	0.248
CTX 1 [ng/mL]	SCP	66	0.81 ± 0.40	0.80 ± 0.35	0.747
	Placebo	**65**	**0.68 ± 0.31**	**0.80 ± 0.58**	**0.011**

Muscle Damage and Recovery



Amino Acids (2019) 51:691–704
https://doi.org/10.1007/s00726-019-02706-5

ORIGINAL ARTICLE

The effects of collagen peptides on muscle damage, inflammation and bone turnover following exercise: a randomized, controlled trial

Tom Clifford[1] · Matthew Ventress[2] · Dean M. Allerton[2] · Sarah Stansfield[2] · Jonathan C. Y. Tang[3,4] · William D. Fraser[3,4] · Barbara Vanhoecke[4] · Janne Prawitt[4] · Emma Stevenson[1]

Received: 18 October 2018 / Accepted: 19 January 2019 / Published online: 19 February 2019

- 24 recreationally active males
- Collagen or maltodextrin given as 10 g sachet with 80 mg Vit C twice daily for 7 days, then 3 days following muscle damaging exercise
- 150 countermovement jumps to induce muscle damage
- Outcomes assessed:
  - Muscle soreness
  - Muscle function
  - Muscle damage/inflammatory markers
  - Bone collagen turnover

Muscle Damage and Recovery

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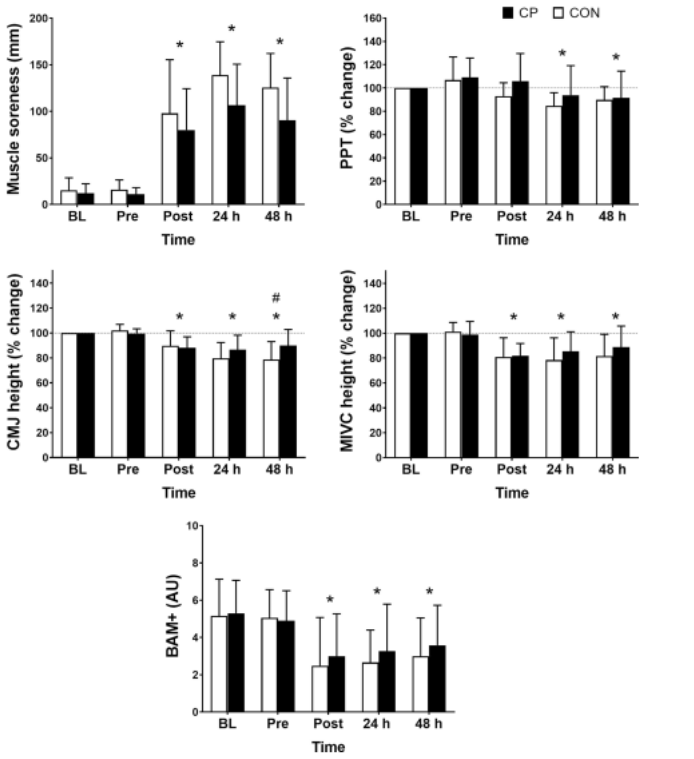


Fig. 1 Muscle soreness, pressure pain threshold (PPT), countermovement jump (CMJ) height, maximal isometric voluntary contraction (MIVC) and Brief Assessment of Mood Adapted (BAM+) at baseline (BL), pre-exercise (Pre), post-exercise (Post), 24 h and 48 h post-exercise after collagen peptides (CP) or control (CON). PPT, CMJ and MIVC data presented as % of baseline values shown in Table 1. *Denotes time effect, $P < 0.05$. #Denotes group × time interaction effect, $P < 0.05$

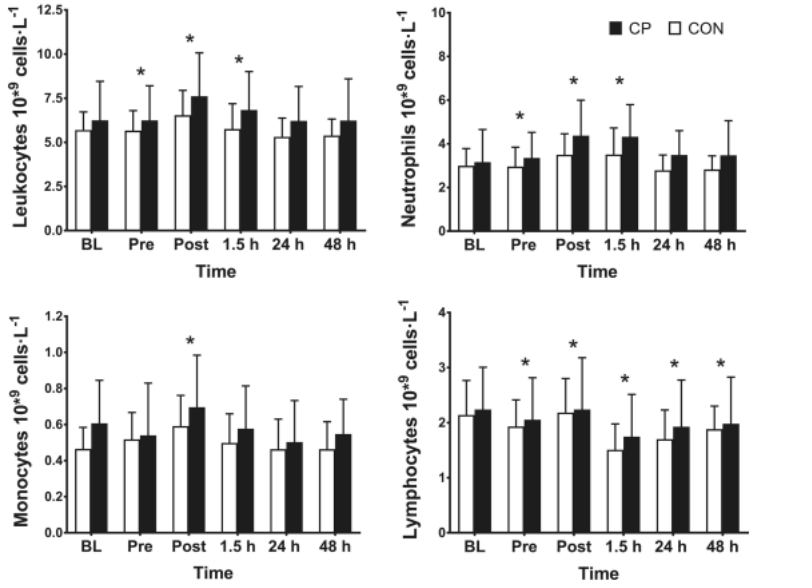


Fig. 2 Leukocytes, neutrophils, monocytes and lymphocytes at baseline (BL), pre-exercise (Pre), post-exercise (Post), 1.5 h, 24 h and 48 h post-exercise after collagen peptides (CP) or control (CON). *Denotes time effect, $P < 0.05$

Hodge podge of supplement protocols and interventions

Study Authors	Supplement Type	Dose	Frequency	Duration	Placebo	Additional Notes
Praet, SFE; Purdam, CR; Welvaert, M; Vlahovich, N; Lovell, G; Burke, LM; Gaida, JE; Manzanero. S; Huges, D; Waddington, G1	Collagen Peptides (Tendoforte)	2.5 g	Twice daily	3 months	Maltodextrin	Taken 30 min before exercise
Dressler P, Gehring D, Zdzieblik D, Oesser S, Gollhofer A and Konig D2	Collagen Peptides	5 g	Daily	6 months	Maltodextrin	Combined with mechanical loading protocol
Lee J, Tang JCY, Dutton J, Dunn R, Fraser WD, Enright K, Clark DR, Steward CE and Erskine RM3	Hydrolyzed Collagen	15 g, 30 g	Once before exercise	Single session	Maltodextrin	Compared with 15 g and 0 g doses
Bongers CCWG, Ten Haaf DSM, Catoire M, Kersten B, Wouters JA, Eijsvogels TMH and Hopman MTE4	Collagen Peptides	10 g	Daily	12 weeks	Placebo	No significant difference in knee pain compared to placebo
Konig D, Oesser S, Scharla S, Zdzieblik D, and Gollhofer A5	Specific Collagen Peptides (Fortibone)	5 g	Daily	12 months	Maltodextrin	Improved bone mineral density in postmenopausal women
Clifford T, Ventress M, Allerton DM, Stansfield S, Tang JCY, Fraser WD, Vanhoecke B, Prawitt J, and Stevenson E6	Collagen Peptides (Peptan)	10 g	Twice daily	7 days	Isoenergetic, Isovolumic	Taken before and after strenuous exercise
Jerger S, Centener C, Lauber B, Seynnes O, Sohnius T, Jendricke P, Oesser S, Gollhofer A, and Konig D7	Specific Collagen Peptides (Tendoforte)	5 g	Daily	14 weeks	Maltodextrin	Combined with high load resistance training
Kviatkovsky SA, Hickner RC, Cabre HE, Small SD, and Ormsbee MJ8	Collagen Peptides	0 g, 10 g, 20 g	Twice daily	6-9 months	Maltodextrin	Improved function, pain, and physical and mental outcomes in active adults
Wageh M, Fortino SA, Pontello R, Maklad A, McGlory C, Kumbhare D, Phillips SM, and Parise G9	Collagen Peptides	20 g	Twice daily	10 weeks	20 g whey protein isolate, 2.5 g creatine monohydrate, 2 g leucine, 300 mg calcium citrate and 1000 IU vit D	0.6 g added glycine and 1.4 g added alanine

Practical Applications

- Healthy athletes – focus on balanced diets with complete sources of protein
  - If an athlete can afford it, a collagen supplement may be helpful to reduce joint pain – but don't make this a key priority of nutrition program

- 10-30 g of collagen, taken 1 hour prior to activity/rehab may provide a benefit to athletes looking to prevent or recover from:
  - Tendon/joint injuries
  - Bone injuries
  - Muscle damage

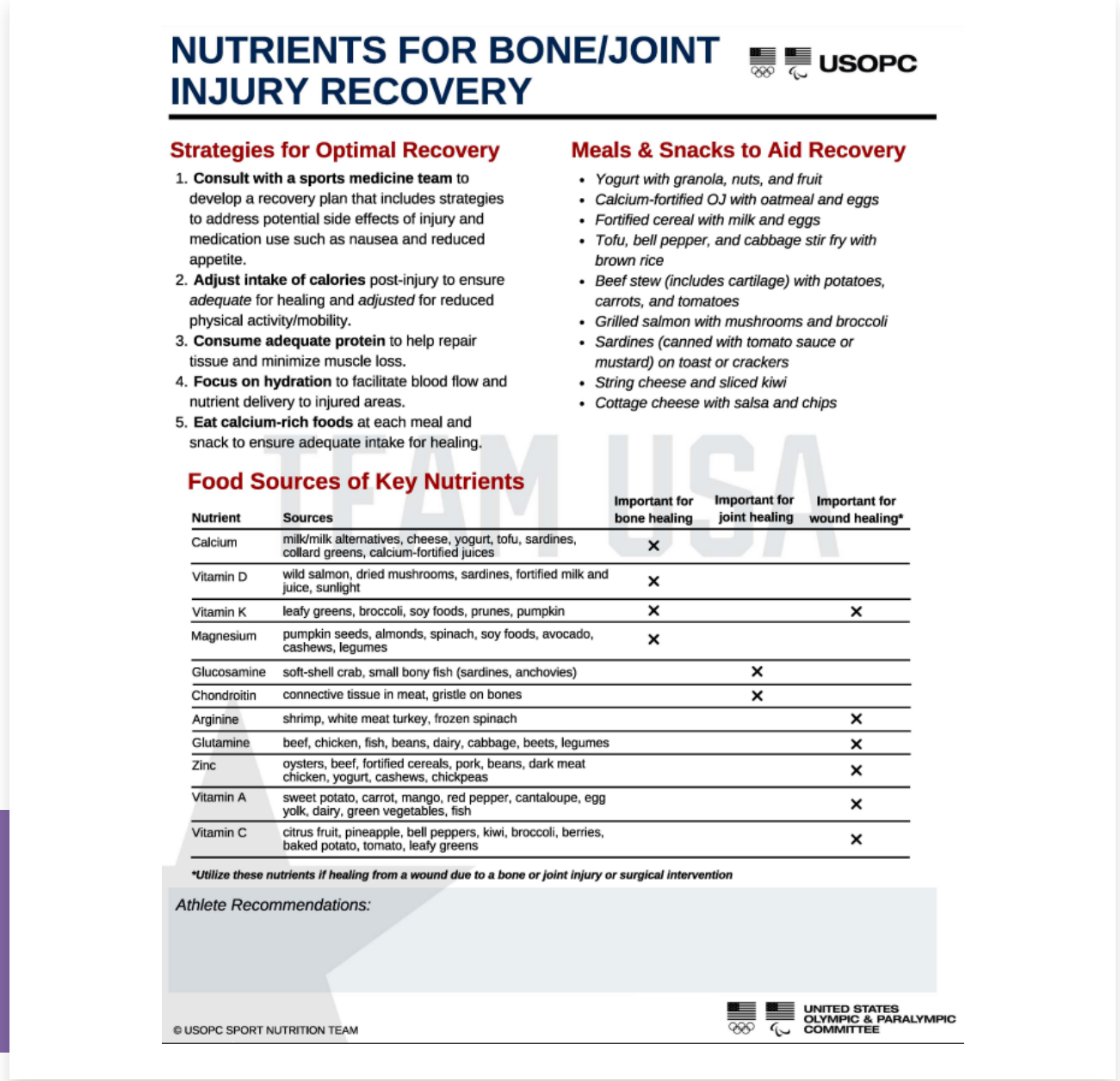
- Always recommend third party tested supplements

Third-Party Supplement Testing Resources
NSF International
Informed Choice and Informed Sport
Banned Substances Control Group
US Pharmacopeia
ConsumerLab.com

Beware of the Supplement Industry

https://www.nsfsport.com/certified-products/

https://sport.wetestyoutrust.com/



NUTRIENTS FOR BONE/JOINT INJURY RECOVERY

USOPC

Strategies for Optimal Recovery

1. **Consult with a sports medicine team** to develop a recovery plan that includes strategies to address potential side effects of injury and medication use such as nausea and reduced appetite.
2. **Adjust intake of calories** post-injury to ensure *adequate* for healing and *adjusted* for reduced physical activity/mobility.
3. **Consume adequate protein** to help repair tissue and minimize muscle loss.
4. **Focus on hydration** to facilitate blood flow and nutrient delivery to injured areas.
5. **Eat calcium-rich foods** at each meal and snack to ensure adequate intake for healing.

Meals & Snacks to Aid Recovery

- *Yogurt with granola, nuts, and fruit*
- *Calcium-fortified OJ with oatmeal and eggs*
- *Fortified cereal with milk and eggs*
- *Tofu, bell pepper, and cabbage stir fry with brown rice*
- *Beef stew (includes cartilage) with potatoes, carrots, and tomatoes*
- *Grilled salmon with mushrooms and broccoli*
- *Sardines (canned with tomato sauce or mustard) on toast or crackers*
- *String cheese and sliced kiwi*
- *Cottage cheese with salsa and chips*

Food Sources of Key Nutrients

Nutrient	Sources	Important for bone healing	Important for joint healing	Important for wound healing*
Calcium	milk/milk alternatives, cheese, yogurt, tofu, sardines, collard greens, calcium-fortified juices	×		
Vitamin D	wild salmon, dried mushrooms, sardines, fortified milk and juice, sunlight	×		
Vitamin K	leafy greens, broccoli, soy foods, prunes, pumpkin	×		×
Magnesium	pumpkin seeds, almonds, spinach, soy foods, avocado, cashews, legumes	×		
Glucosamine	soft-shell crab, small bony fish (sardines, anchovies)		×	
Chondroitin	connective tissue in meat, gristle on bones		×	
Arginine	shrimp, white meat turkey, frozen spinach			×
Glutamine	beef, chicken, fish, beans, dairy, cabbage, beets, legumes			×
Zinc	oysters, beef, fortified cereals, pork, beans, dark meat chicken, yogurt, cashews, chickpeas			×
Vitamin A	sweet potato, carrot, mango, red pepper, cantaloupe, egg yolk, dairy, green vegetables, fish			×
Vitamin C	citrus fruit, pineapple, bell peppers, kiwi, broccoli, berries, baked potato, tomato, leafy greens			×

Utilize these nutrients if healing from a wound due to a bone or joint injury or surgical intervention

Athlete Recommendations:

UNITED STATES OLYMPIC & PARALYMPIC COMMITTEE

US Olympic and Paraolympic Committee Nutrition has resources for Bone, Joint and Soft Tissue injury recovery

https://www.usopc.org/nutrition