

An Examination to See If There Is a Positive Relationship  
Between Nutritional Supplementation Strategies and The  
Body's Ability to Regenerate After Injury

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## Abstract

People who have injured themselves most of the time go to the hospital. Doctors are seen who have gone to medical school and been encouraged to prescribe pills, and that is the totality of the event. No one speaks about the proper nutrition and how that encourages a shorter healing period. In turn many people do not seem to realize the vital role nutrition plays in recovery. This Capstone asks, does a positive relationship exist between nutritional supplementation strategies and the body's ability to regenerate after injury? Can nutrition benefit the human body during recovery? The answer to this research question is unequivocally yes, nutrition benefits healing in many ways and should be part of any treatment plan. Not only protein powder, in particular, but also Creatine Monohydrate, Vitamin D, and Omega 3. These findings have significant importance because they give the tools to individuals to improve their health. Then the question becomes why doctors do not incorporate this into a patient's recovery plan?

## Chapter 1: Introduction

Injuries are abundant globally and present themselves in athletes during their sport, in adults during recreation, and in children during play. I have had my share of injuries and the time span during which recovery takes place is always too long. During which time athletes are restricted from practice, adults fulfilling their responsibilities becomes a challenge, and children loose enjoyment from play. Does a positive relationship exist between nutritional supplementation strategies and the body's ability to regenerate after injury? The research indicates an undeniable yes. This finding indicates we can improve aspects of the healing process such as reducing the time it takes, the quality of the injury regeneration, and preventing injuries in the future. Returning the out-of-service individual back to being a productive member of society quickly is a goal sought after by everyone.

Does a positive relationship exist between nutritional supplementation strategies and the body's ability to regenerate after injury? I proceeded toward secondary sources and used ten peer reviewed articles to gain answers to this question. The answer to my question might take some of you by surprise, but it is logical to think what you put in is what you get out. If a healthy diet is that powerful, why do medical doctors not advise on nutrition? What is being done about this gap between nutrition and medical doctors? Doctors are skilled at prescribing drugs, but probably couldn't tell you all the benefits of an apple. This paper covers various elements that benefit good health along with strategies to implement these elements into a person's diet. These foods, supplements and courses of action are expressed to accommodate someone new to a healthy diet.

Conveying what works is the primary goal of this document, but limitations do exist. I cannot list every nutrient known and it is strongly suggested that anyone with interest in learning more carefully evaluate and consult registered professionals. You will learn that health problems that cause you to see a medical doctor are sometimes the result of having a bad diet to begin with. Then the connection will fortify itself between medical doctors and proper nutrition. Many studies take months and years to complete and result in only a few answers. I chose secondary

research for this reason. The work has been done, the results are in, and now I can benefit from those results, and assemble a number of different research results to bring forth a more complete and stable answer.

With these answers, the choice then becomes yours with improvement of your own health. Understandably, people work but do not get paid enough to buy healthy food. It seems as if a budget that includes healthy food is a luxury. Additionally, many poor neighborhoods are established in food deserts. This leaves the residents making tough choices such as buying chips at the local store or travelling significantly longer to obtain healthier food choices. So, then the question arises as to whether health insurance companies should consider incorporating payouts for healthy food purchases. After all, preventive maintenance is usually cheaper. Consuming a diet with nutritious food is not just for the injured. A healthy diet is a way of supporting the human body on a daily basis. It is preventive maintenance not just to avoid disease, but physical injury as well.

Taking care of your body results in your body taking care of you. What I mean by that is; if you eat healthy, and strategize your dietary intake, you benefit physically. You can be around for your family longer, you can enjoy coming home from work not being so tired, and overall thrive in a more alert state of being. Taking a step back, you can see a benefit to the economy as well. It is cheaper for the purchase of fruits and vegetables than for the transaction of a drug that may cause side effects and result in more spending to buy more drugs to combat those new problems. Maybe that is why medical doctors and hospitals often get free samples. Even if time constraints present themselves as keeping you from improving your diet, supplements with vitamins, minerals, and protein can fill the void in what an individual needs to do right for themselves. This paper is not a complete guide as the elements advantageous to the body are extensive and new discoveries are continuous. While a healthy intake supports a well-functioning body, it is not a substitute for exercise. These two areas should supplement each other for the best results.

## Chapter 2: Literature Review

Does nutrition help in recovery and regeneration after an injury? From the perspective of a person that has endured multiple injuries, being part of community, and rejoining society as a productive member is better sooner than later. From the injured person's point of view, regaining the lost abilities will assist them in meeting their personal obligations, and return them to their former lifestyle. From the standpoint of competition, an athlete needs to return to their sport as quickly as possible to keep the competitive edge and sustain their popularity with fans. With that, healing from damage to the body cannot come quick enough. The importance of recovery is apparent in the abundant amount of research done on this subject represented in the vast number of articles available. While the articles I collected point to different dietary substances, and I expanded on them, I noticed similarities. I saw a pattern of repetition with nutrition sources such as minerals, vitamins, protein, and at the top is Omega-3.

In the article "The Role of Vitamin D in Skeletal Muscle Repair and Regeneration in Animal Models and Humans: A Systematic Review (2023)," by Miguel Agoncillo, Josephine Yu, and Jenny E. Gunton from Centre for Diabetes, Obesity and Endocrinology (CDOE) in The Westmead Institute for Medical Research at The University of Sydney, they examine the impact of including Vitamin D in skeletal muscle repair. This review holds much weight because they researched from the perspective that injuries are common in society and reducing the time that is required for a person to recover from an injury properly has positive results for both a person's personal life and work obligations. These authors gathered secondary information using the PRISMA guidelines with the question 'What role does vitamin D have in inducing skeletal muscle repair and regeneration in animals and humans?' on PubMed, Web of Science, Cochrane Library, and Scopus online databases. When examining the gathered data, it was apparent that Vitamin D plays a necessary role in the regeneration and maintenance of muscle function. The results of this research encouraged the writers to promote Vitamin D supplement intake. This paper has a high-quality level considering my research dives into this very topic. From the importance of Vitamin D we will begin to investigate the significance of Omega-3.

In the article "The Role of Omega-3 Polyunsaturated Fatty Acids and Their Lipid Mediators on Skeletal Muscle Regeneration: A Narrative Review (2023)," by Sebastian Jannas-Vela, Alejandro A. Candia, Marcelo Flores-Opazo who are from Instituto de Ciencias de la Salud, Universidad de O'Higgins, Alejandra Espinosa from Escuela de Medicina, Campus San Felipe, Universidad de Valparaíso, Luis Peñailillo from Exercise and Rehabilitation Sciences Institute, School of Physical Therapy, Faculty of Rehabilitation Sciences, Universidad Andres Bello, and Rodrigo Valenzuela from Department of Nutrition, Faculty of Medicine, University of Chile research what role Omega-3 polyunsaturated fatty acids and their lipid mediators play on skeletal muscle regeneration?

The importance of this research question is significant because if Omega-3 polyunsaturated fatty acids and their lipid mediators play a role in regeneration of skeletal muscle tissue then greater attention should be placed on combining this ingredient in a person's diet especially during recovery from an injury. These authors gathered secondary data by means of an online search. After analysis of the data they gathered, it was concluded that Omega-3 polyunsaturated fatty acids and their lipid mediators had a positive impact on skeletal muscle regeneration. The results of their review caused them to suggest that a daily supplement of fish oil containing Omega-3 would have a positive impact on a person's health and recovery if they had an injury. The reliability of this paper is high because it directly provides an answer to my research question with an ingredient that a person can include in their diet. The value of Omega-3 is enormous, and we will continue to talk about this nutrient in the next article.

In the article "Regulation of Skeletal Muscle Satellite Cell Differentiation by Omega-3 Polyunsaturated Fatty Acids: A Critical Review (2021)" by Peter O. Isesele professor of Criminology & Associate Dean in Faculty of Arts of the University of Alberta in Canada and Vera C. Mazurak professor at University of Alberta examined the role of Omega-3 polyunsaturated fatty acids on myogenic differentiation of satellite cells. The question being researched here is essential because of the importance of the reduction in recovery time. The creators of the article gathered data using the keywords omega-3 PUFAs, eicosatetraenoic acid (EPA), docosahexaenoic acid (DHA), satellite cell, skeletal muscle stem cell, stem cell, AND skeletal muscle, and myogenesis on the online database known as PUBMED MEDLINE. The authors then inspected the gathered data and produced the idea that Omega-3 unsaturated fatty

acids are a vital ingredient in the recovery process. The research satisfied their review, but because the studies used were not on humans, they did not want to extrapolate the results to people. This review receives a medium because of the usage of animals for the tests. Omega-3 is an essential part of the diet, and we will consider diet strategies and the importance of the body's stem cells.

In the article "100 Years of Exploiting Diet and Nutrition for Tissue Regeneration (2021)," by Chia-Wei Cheng from the Department of Genetics and Development at Columbia University, and O'mer H. Yilmaz from the Department of Biology at MIT present diet through the lens of regenerative health. This investigation is significant because if nutrition plays a crucial role in physical health and a person's lifespan, then it can be recommended to patients. The writers used secondary data in their qualitative study from the online source [frontiersin.org](https://www.frontiersin.org). In this review it was found that the idea of incorporating a healthy diet into the overall process of recovery has been around historically and shown itself to be true. With these results the authors suggested in the future dietary strategies that could be discovered that would promote stem cell performance resulting in a quicker recovery from injury or disease. I find this paper to be of a high-quality level because it directly answers my research question. The significance of strategies when it comes to diet is important and next we will consider protein.

In the article "Rehabilitation Nutrition for Injury Recovery of Athletes: The Role of Macronutrient Intake (2020)" by Sousana K. Papadopoulou who is at the Department of Nutritional Sciences and Dietetics, Faculty of Health Sciences at International Hellenic University inquired, what nutrition would speed up recovery for athletes after injury and surgery? This review is important because it provides a basic diet to hasten recovery after surgery. The author gathered information from secondary sources online through the CrossRef and PubMed databases. After reviewing the data, they gathered they compiled it together and reorganized it to be used as reference. The paper is of high quality because it references nutrients and connects them with the role they play in recovery, which answers my research question. Protein is a cornerstone to good health and in the next paper we will discuss Caffeine, Beetroot juice, and Sodium Bicarbonate.

In the article "Nutritional Strategies to Optimize Performance and Recovery in Rowing Athletes (2020)" by Jooyoung Kim from the Office of Academic Affairs at Konkuk University

and Eun-Kyung Kim from the Division of Food Bioscience at the College of Biomedical and Health Sciences developed strategies in nutrition to increase performance and recovery in rowing athletes based on literature they reviewed. This question is important because the essential role nutrition plays is not well known. These authors gathered secondary data from online sources CrossRef and PubMed. With this research the writers performed they produced this paper to emphasize the knowledge the nutrition positively impacts recovery and supports efficient physical capabilities. The researchers gathered data and were able to verify their claims and circulate this information through this publication. They then advocated the need for athletes to consider factors such as goals and the environment they are in to gain better results in their training. I consider this paper to be of a high-quality level and would be beneficial to my project because it promotes the positive effects of nutrition during recovery. From the findings of the benefits of Caffeine, Beetroot juice, and Sodium Bicarbonate, we continue the investigation with the work up next mentioning Creatine, Collagen, Vitamins C, D, E as well as Calcium.

In the article "Nutritional Considerations for Injury Prevention and Recovery in Combat Sports(2021)" by Hüseyin Hüsrev Turnagöl, Sükran Nazan Koşar, Yasemin Güzel, Selin Aktitiz and Muhammed Mustafa Atakan whom are all from the Hacettepe University, and have questioned what are the nutritional strategies available that are aimed at reducing the risk of injury and compliment the recovery process in Combat sports. The question of research holds much weight because if true, nutrition would improve injury recovery and promote injury prevention. The essayist has gathered secondary data through online databases called CrossRef and PubMed. Upon scrutinizing the data, they found information showing a promising connection between nutrition intake and the prevention and recovery of injuries. The findings within this paper help support the reduction of injury risk and injury recovery. The paper is of high quality because it provides a direct answer to my research. Creatine, Collagen, Vitamins C, D, E, and Calcium play essential roles in good nutrition and the next article mentions Vitamin C, Coenzyme Q10, and Probiotics.

In the article "An overview of nutritional strategies for recovery process in sports-related muscle injuries(2018)" by Katherin Johana Quintero from the Faculty of Medicine in the National University of Colombia, Ayane de Sá Resende, Geovana Silva Fogaça Leite and Antonio Herbert Lancha Junior who are from the Laboratory of Applied Nutrition and

Metabolism in the School of Physical Education and Sports at University of Sao Paulo presented a review of nutritional strategies using proteins, antioxidants, Omega-3 fatty acids, and probiotics after a muscular sports injury. This research question is important because it aims at promoting a quick return to being active. The writers consolidated secondary information from PubMed, Science Direct, Scielo, Embase, and Google Scholar databases. Upon analyzing the data an overview was created of dietary strategies to complement recovery from muscular injuries. The data proved essential as evidence of the significance of proper nutrition to quicken the healing process. I rate the paper of high quality because it supplies the proof needed to form a result to my research. Vitamin C, Coenzyme Q10, and Probiotics have a place in a person's diet according to the research, and the next work shows the need for Vitamin A, and Complex Carbohydrates.

In the article "Nutritional Considerations and Strategies to Facilitate Injury Recovery and Rehabilitation (2020)" by Abbie E. Smith-Ryan, PhD, CSCS\*D, Katie R. Hirsch, MA, Hannah E. Saylor, MS, RD, Lacey M. Gould, BS, and Malia N. M. Blue, MA whom collectively are from Department of Exercise and Sport Science, Human Movement Science Curriculum, and Department of Nutrition, Gillings School of Public Health, University of North Carolina at Chapel Hill provide a guide for injured athletes with and without surgery to assist their healing and rehabilitation. What makes this commentary so substantial is that it was published to be a practical guide for athletes after injury. The authors collected the information and invested it in print that is readily available. They used the results to develop a guide that would help others with prevention and recovery from injuries. I consider this paper of high quality because it provides the nutrition needed and its effects for my research. With the need for Vitamin A, and Complex Carbohydrates established we will next review the importance of Vitamins K and the B-complex, Magnesium, Selenium, Zinc, Calcium, Iron, Omega-6 and Omega-9.

In the article "The Role of Dietary Nutrients in Peripheral Nerve Regeneration (2021)" by Federica Zen from Department of Clinical and Biological Sciences at the University of Torino, Marwa El Soury, Benedetta Elena Fornasari, Giacomo Carta, and Giulia Ronchi whom are from the Neuroscience Institute Cavalieri Ottolenghi (NICO) in Italy, and Kirsten Haastert-Talini who is from the Institute of Neuroanatomy and Cell Biology at Hannover Medical School and Center for Systems Neuroscience in Germany probed what nutrients maintain and assist in regenerating

the peripheral nervous system. This review is important because daily activities may result in injury to the nervous system. The authors collected information via the internet from the databases known as CrossRef and PubMed. As the writers reviewed the data, they developed a reference guide associating nerve regeneration with dietary nutrient consumption. With those nerve regenerating, nutrient intake connections they created this resource to assist in a person's recovery. I find this paper to be of high quality due to their mentioning of what nutrients promote what benefits and the linking of what dietary strategies cause what desired outcomes.

The purpose of this literature review is to find out if there is a positive relationship between nutritional supplementation strategies and the body's ability to regenerate after injury. I was met with more than enough information that declares nutrition has a positive impact on recovery. All the sources I used, used secondary data as well. The research done was on either animals or humans and at no time did I find any conflicts of interest. I started to see the same components used in a diet that promoted recovery and regeneration though.

## Chapter 3: Methods

The objective of this study is to find empirical evidence that determines if a positive relationship exists between nutritional supplementation strategies and the body's ability to regenerate after injury. This would make a positive significant impact for anyone requiring or wanting to heal faster, improve the quality of regeneration, prevent future injuries, or live a healthier lifestyle. I choose to use secondary data as that would include more studies with more reviews, and more interpretations.

### Selection criteria

Medicine is always changing because new discoveries are continuously being made. My selection criteria had to be as recent as possible. This is not to say old healing methods do not work, but rather, aside from streamlining older practices, we can be introduced to new ones. I wanted a sufficient pool of articles to choose from that match the criteria of nutrition being used in whole or part to treat injuries. This resulted in a time frame being selected from 2000 to present. The oldest article was from 2018 with all the others conducted from 2020 to 2023. Some studies mentioned human involvement, while the others spoke of mice, and all were acceptable. Only articles in English were used. Out of the twelve articles selected, two were eliminated due to their medical complexity and lack of talking about a substance that the average person could purchase at a store and include in their diet.

### Search terms

I gathered secondary data via the internet on the SUNY library database to answer this question. Using one search bar, it covered 159 databases. I used one or more of the following keywords alone or together to produce the sum of articles: nutrition, diet, injury, health, sports, combative sports, athletic injuries, muscle repair, regeneration, and recovery.

### Data collection and analysis methods

The data is mostly composed of articles talking about secondary data, so they were secondary themselves. This was the best route because the studies done took a substantial amount of time which is outside the time limit of this report. Additionally, the variety and number of tests done would also surpass my own capabilities. The benefit of secondary research also opens the door for more interpretations of the data accumulated. The data was then collected by element category. For example, all information about vitamin D was grouped together.

#### Study quality and risk of bias

Based on the use of peer-reviewed research, the quality of this study is high. The ten remaining articles selected had authors who worked as doctors or researchers or in similar areas of academics. Each author was examined to determine if the article written was done so without bias, and everyone was proven to be clear of bias. I suffered a back injury years ago and became interested in nutrition and injury healing myself.

The objective is to find empirical evidence that determines if a positive relationship exists between nutritional supplementation strategies and the body's ability to regenerate after injury. Using the most recent peer-reviewed articles that were constructed as to answer this question, I hope to find a definite answer. The results showed repeatedly that protein was a cornerstone to regeneration, and even more so, Omega-3 proved vital towards good health. It was also made clear that the nutrition these articles support was more effective when used with dietary strategies. I have started with protein and its varieties, then I mention vitamins, minerals, and talk about plans to take these components.

## Chapter 4: Findings

In this paper I will examine if there is a positive relationship between nutritional supplementation strategies and the body's ability to regenerate after injury. To establish a clear and reliable answer my efforts focused on peer reviewed articles. I utilized online databases with a focus on understandable terminology in easy to incorporate plans for anyone to use. My research will discuss the results in order from the main compound of protein and all of its variations. I will go over numerous vitamins and their roles for good health. Next, I will dive into multiple minerals and their health-giving effects. After, you will be introduced to strategies to on how to implement these components for the best results. Lastly, I will reveal algorithms for the compounds I mentioned that I have learned in my personal plight from maintaining good health to recovery after injury.

### Vitamin D

Muscle weakness, falls, and Sarcopenia are problems connected with Vitamin D deficiency (Agoncillo et al., 2023). In a test done with mice, a diet with low amounts of Vitamin D (Cholecalciferol,  $C_{27}H_{44}O$ ) was shown to decrease muscle volume (Agoncillo et al., 2023). After, the level of Vitamin D was increased to normal and that reversed the effects caused by the previous diet (Agoncillo et al., 2023). This shows the need for enough Vitamin D for a proper diet. Vitamin D plays a direct role in muscle repair and function (Smith-Ryan et al., 2020). Another test done with mice with their muscular receptor for Vitamin D removed was shown to reduce speed, endurance, and grip strength (Agoncillo et al., 2023). Similar effects were shown in studies with humans of all ages when Vitamin D supplementation was used with exercise (Agoncillo et al., 2023). Vitamin D works with Calcium to increase quality of healing from bone fractures (Turnagöl et al., 2021). More specifically, Vitamin D3 was shown to increase the regeneration of peripheral nerves (El Soury et al., 2021).

Sunlight is a reliable source for Vitamin D (Agoncillo et al., 2023), but for those who cannot spend enough time outside in UVB, food intake from sources such as cheese, yogurt, fish, orange juice and cereals may be sufficient (Smith-Ryan et al., 2020). Supplements are another alternative, and daily consumption of at least 1000IU is the recommended amount (Agoncillo et

al., 2023). An online search shows a variety of Vitamin D supplements from dropper, gummy, gel tablet to pill form each with varying amounts and requiring a different number taken to form a serving size shows most of these with a price range between \$10-\$20. There are more expensive versions, but cost does always equate to quality. The best form of any compound is found naturally in food. Then again eating all the food items or number of food items to obtain the minimum dose you require is not always feasible and a supplement becomes the go-to.

### Omegas

Muscle loss from injury or old age can be reduced with the incorporation of Omega-3 into a person's diet (Turnagöl et al., 2021). The three main omega-3 fatty acids are alpha-linolenic acid  $C_{18}H_{30}O_2$  (ALA), Eicosapentaenoic acid  $C_{20}H_{30}O_2$  (EPA), and docosahexaenoic acid  $C_{22}H_{32}O_2$  (DHA). ALA is found in plant oils such as flaxseed, soybean, and canola oils. DHA and EPA are found in fish and other seafood (Papadopoulou., 2020). During an injury it is common for inflammation to occur which is a needed trigger for the regeneration process to begin (Jannas-Vela et al., 2023). Satellite cells begin the conversion of turning into muscle fibers (Isesele et al., 2021).

Omega-3 keeps inflammation down and assists satellite cells in performing their function (Isesele et al., 2021). How this process works is not clear (Isesele et al., 2021). Omega-3 has been shown to enhance anabolic sensitivity to amino acids (Turnagöl et al., 2021) which is beneficial to individuals who supplement with protein and increase the functional capacity of the muscle. Omega-3 consumption plays a role in visual and neural development, while also helping to relieve neuropathic pain (El Soury et al., 2021). More research needs to be done to find out how Omega-3 positively impacts the forementioned areas. Omega-6  $CH_3(CH_2)_4(CH=CHCH_2)_x(CH_2)_yCOOH$  assists in muscle regeneration and acts as an anti-inflammatory (Jannas-Vela et al., 2023). Omega-7  $CH_3(CH_2)_5CH=CH(CH_2)_7COOH$  and Omega -9  $CH_3(CH_2)_7CH=CH(CH_2)_7COOH$  both promote anti-inflammation and reduce the risk of heart disease (Jannas-Vela et al., 2023).

### Protein – whey, Casein, Creatine monohydrate

Protein  $RCH(NH_2)COOH$  comes in many forms and the chemical formula is generally the same. Skeletal muscle occupies approximately 40% of total body weight, and accounts for 30–50% of the entire body's protein turnover, stores and utilizes substrates, including amino acids and carbohydrates (Isesele et al., 2021). The goal of rehabilitative nutrition is to provide enough calories and protein to aid in healing and prevent a loss of lean body mass (Smith-Ryan et al., 2020). Amino acids, protein intake, antioxidants, creatine, and omega-3 are given special attention due to their therapeutic roles in preventing muscle loss and anabolic resistance as well as promoting injury healing (Turnagöl et al., 2021).

Increasing and balancing your protein intake throughout the day with exercise will reduce muscle loss and speed up healing time (Turnagöl et al., 2021). “One of the best ways to recover muscle mass is exercise interventions (i.e., resistance training)” (Turnagöl et al., 2021). “In a study conducted with elderly patients hospitalized for hip fracture, the intervention group (n = 20) received 32.2 g of whey protein in the pre- and post-rehabilitation period in a postoperative period for 2 weeks. Participants in the whey protein group had significantly greater improvements in knee extension strength in the operated limb and non-operated limb compared with the control group and improvement in functional activities of daily life” (Quintero et al 2018). Athletes who have injured themselves can reduce weight gain, and still meet the nutritional needs of recovery with a diet including a greater proportion of protein in combination with complex carbohydrates (Turnagöl et al., 2021).

One dietary plan to maintain the macronutrient composition is with a 2:1 carbohydrate-to-protein ratio (e.g., 240 g of carbs and 120 g of protein), and this has shown positive changes in body composition (Turnagöl et al., 2021). “It is well-documented that muscle protein breakdown accelerates during injury recovery process” (Turnagöl et al., 2021). Protein should also be considered when recovering from bone injuries (Turnagöl et al., 2021). There have been studies that reported BCAAs such as leucine, isoleucine, and valine can boost healing after a musculoskeletal injury as well as increase protein synthesis and inhibit protein breakdown (Turnagöl et al., 2021). Protein is available in many foods, but to ensure you get protein with a focus on Leucine you should aim to consume “chicken, beef, milk, and fish (Smith-Ryan et al., 2020). If you are leaning towards supplementation of protein, the highest quality protein is Whey (Smith-Ryan et al., 2020). Whey protein is available in all assorted sizes, under all different

names, and typically in Chocolate, Vanilla, and Strawberry flavors. A person will be looking to pay \$50 to \$90 for a 5-pound jug of powder depending on if it is Concentrate or Isolate and the name of the manufacturer.

Casein protein  $C_{81}H_{125}N_{22}O_{39}P$  like Whey protein is derived from milk, but unlike Whey protein, is slower to digest (Smith-Ryan et al., 2020). It is recommended to consume 30g to 40g of Casein protein before bed (Smith-Ryan et al., 2020). My personal experience has shown the intake of Casein protein significantly increases appetite. It is important to mention that other proteins available that are plant-based do not deliver as much and, or the same amino acids that Whey protein contains per scoop. Soy protein comes close, and I have tried it but kept returning to the superior Whey protein.

Creatine  $CNCH_2CO_2H$  is found in milk, red meat and seafood. Consumption of creatine monohydrate (from 20 g down to 5 g daily) with 10 weeks (3 days/week) of rehabilitation exercises increased muscle hypertrophy in disuse atrophy caused by 2 weeks of leg immobilization (Turnagöl et al., 2021). From personal experience with creatine, some people use a loading dose (20g) followed by a maintenance dose (5g) to obtain a proper amount of Creatine in their body as quickly as possible. That works, but just taking a maintenance dose (5g or whatever the Creatine container states) everyday will result in creatine levels building up in your body too, it would just take a little longer. My experience with Creatine Ethyl Ester  $C_6H_{13}N_3O_2$  has proven to be more effective, and more expensive than the more popular Creatine Monohydrate. You can obtain one pound of Creatine Monohydrate powder for a cost of \$20 at its lowest price. Creatine Monohydrate is the version used in the research I reviewed, and that is the version I suggest incorporating into your diet if you choose to do so.

Collagen  $C_4H_6N_2O_3R_2 \cdot (C_7H_9N_2O_2R)_n$  is a protein found in connective tissue such as tendons and ligaments. It is also a building block of bones, muscles, and skin. “Collagen is rich in glycine, proline, hydroxylysine, and hydroxyproline, and consumption of these amino acids increases collagen synthesis as well as improves the ligament–tendon structure” (Turnagöl et al., 2021). Athletes with chronic ankle injuries saw reductions in the number of ankle injuries following ingestion of 5 g of collagen peptide for 6 months (Turnagöl et al., 2021). Consumption of 10g to 15 g of hydrolyzed collagen every day seems to be an effective strategy for the prevention and treatment of joint, tendon, and ligament injuries (Turnagöl et al., 2021). You can

gain Collagen through Gelatin  $C_6H_{12}O_6$ , and you can get Gelatin by boiling tendons, ligaments, bones, and skin that has come from cows, pigs, and fish (Turnagöl et al., 2021). You can also find supplements ranging in price from \$10 to \$30 but be mindful of the quality.

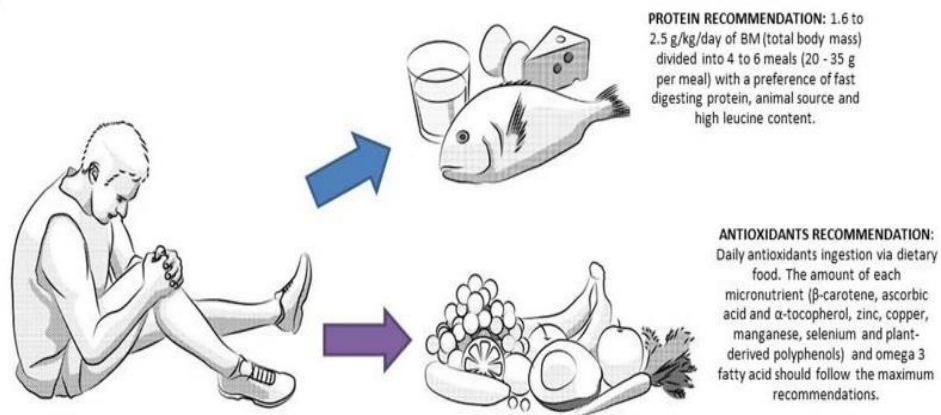


Fig 1. Displaying a combination of food sources for recovery (Quintero, 2018, Fig 2)

### Vitamin A

Vitamin A  $C_{20}H_{30}O$  is lipid-soluble, meaning it is absorbed into the body just as fat would (El Soury et al., 2021). Vitamin A has two forms which are  $\beta$ -carotene from vegetable intake and retinol esters from animal consumption (El Soury et al., 2021). Vitamin A along with other nutrients like Iron, Zinc, Silicon, Vitamin K, Vitamin C, and B Vitamins support metabolic processes for bone tissue (Turnagöl et al., 2021). Micronutrients like Vitamin A and Vitamin C, and Vitamin E support immunonutrition for wound healing and injury recovery (Smith-Ryan et al., 2020). Vitamin A has a vital role in embryonic development, and molecular pathways involved with cognition and learning (El Soury et al., 2021). Vitamin A has significant involvement with development and regeneration in the peripheral nervous system and central nervous system (El Soury et al., 2021). Vitamin A participates in collagen synthesis (Quintero et al., 2018). You can find a Vitamin A supplement for around \$5 to \$20.

### Vitamin C

Vitamin C  $C_6H_8O_6$  is a water-soluble vitamin, meaning it is absorbed into water. Vitamin C, like Vitamin A is necessary for collagen formation (Quintero et al., 2018). A deficiency in Vitamin C causes Scurvy, and that results in collagen loss (Turnagöl et al., 2021). Vitamin C is required for all body tissues with regards to development, growth, and repair (El Soury et al., 2021). Vitamin C helps with Absorption of Iron, maintenance of cartilage, bones, and teeth, and functioning of the immune system (El Soury et al., 2021). Vitamin C has a role in synthesis of neurotransmitters, and recovery of injured nerves (El Soury et al., 2021). Vitamin C, also known as Ascorbic acid, helps with recovery of injured nerves, for example, “animals treated with ascorbic acid showed better motor and sensory performances as well as better electrophysiological results and larger myofibers in the target muscle after sciatic nerve crush injury and increased the number and size of the regenerated axons and the myelin thickness” (El Soury et al., 2021). Vitamin C is being used in a strategy to “improve leukemia treatments by targeting nutritional dependencies of (pre)malignant HSCs” (Cheng et al., 2021). You can get Vitamin C through foods like citrus fruits, strawberries, kiwi, peppers, broccoli, tomatoes, and potatoes (Turnagöl et al., 2021). Vitamin C supplements will cost anywhere from \$8 to \$20.

### Vitamin E

Vitamin E  $C_{29}H_{50}O_2$  is plant derived and comes from vegetables, seeds nuts and oils. Vitamin E decreases oxidative stress, thus decreasing wound healing time (Smith-Ryan et al., 2020). A correlation between Vitamin E deficiency and premature aging was strengthened when rat DRG's had a Vitamin E deficiency and an increased number of neurons which is a trait observed in older rats (El Soury et al., 2021). The proliferation of satellite cells can be controlled by incorporating Vitamin E, with Vitamin D, and carbohydrates (Isesele et al., 2021). Foods that Vitamin E can be found in are peanut butter, sunflower seeds, spinach, red bell pepper, pumpkin, and wheat germ, sunflower, safflower, soybean oils. A supplement for Vitamin E would cost about \$7 to \$20.

	Vitamin C		Vitamin A		Vitamin E										
Main Functions	<ul style="list-style-type: none"> <li>Stimulates collagen synthesis</li> <li>Facilitates wound healing</li> <li>Maintains bone</li> </ul>		<ul style="list-style-type: none"> <li>Increases collagen deposition</li> <li>Proliferation of epithelial cells</li> <li>Decreases inflammation</li> </ul>		<ul style="list-style-type: none"> <li>Modulates muscle proteolysis genes</li> <li>Functions as an antioxidant</li> <li>Enhances immune function</li> </ul>										
Good Sources	Kiwi 131 mg	Grapefruit 94 mg	Orange 93 mg	Strawberries 85 mg	Broccoli 51 mg	Sweet potato 961 µg	Pumpkin 953 µg	Squash 572 µg	Carrots 534 µg	Spinach 472 µg	Sunflower seeds 7.4 mg	Almonds 7.3 mg	Apricots 2.8 mg	Whole avocado 2.7 mg	Spinach 1.9 mg
Recommended Daily Amount	Males: 90 mg Females: 75 mg		Males: 900 µg Females: 700 µg		Males: 15mg Females: 15 mg										

An overview of key micronutrients that have been shown to enhance healing and recovery.

Fig 2. Chart of vitamin sources. (Smith-Ryan et al., 2020, Fig 8)

### Vitamin K

Vitamin K  $C_{31}H_{46}O_2$  is a fat-soluble vitamin that is stored in tissue in a limited amount and should be part of a regular diet (El Soury et al., 2021). Vitamin K is used in blood coagulation in clinical practice and acts as an antioxidant and anti-inflammatory (El Soury et al., 2021). “Vitamin K seems to protect oligodendrocytes and neurons from oxidative injuries and seems to be involved in remyelination after an acute demyelination” (El Soury et al., 2021). Foods containing Vitamin K are green leafy vegetables like kale, spinach, broccoli, cabbage, and other lettuces. You can purchase a Vitamin K supplement for about \$6 to \$20.

### B complex

B complex vitamins include: B<sub>1</sub> Thiamine  $C_{12}H_{17}N_4OS$  is found in whole grains, meat, and fish. B<sub>2</sub> Riboflavin  $C_{17}H_{20}N_4O_6$  is found in milk, eggs, kidneys, liver, and lean meats. B<sub>3</sub> Niacin  $C_6H_5NO_2$  is found in beef, pork, poultry, brown rice, breads, nuts, seeds, legumes, and bananas. B<sub>5</sub> Pantothenic acid  $C_9H_{17}NO_5$  is found in milk, eggs, beef, poultry, seafood, wheat, brown rice, oats, avocados, potatoes, and broccoli. B<sub>6</sub> Pyridoxine  $C_8H_{11}NO_3$  is found in pork, poultry, peanuts, soya beans, wheatgerm, oats, and bananas. B<sub>7</sub> Biotin  $C_{10}H_{16}N_2O_3S$  is found in beef liver, cooked eggs, salmon, avocados, pork, sweet potato, and nuts. B<sub>9</sub> Folate/Folic acid  $C_{19}H_{19}N_7O_6$  is found in turnip greens, spinach, romaine lettuce, asparagus, brussels sprouts, broccoli, beans, peanuts, sunflower seeds, fresh fruits, and whole grains. B<sub>12</sub> Cyanocobalamin  $C_{63}H_{88}CoN_{14}O_{14}P$  is found in lean meats, poultry, eggs, seafood, beans, peas, lentils, nuts, and

seeds. While each B Vitamin has its own number of ways in which it assists the development, maintenance, and repair of the body, and to dive into each aspect is outside the scope this paper, but collectively they benefit the nervous system. A supplement with the B-complex can be purchased for about \$7 to \$22.

### Magnesium

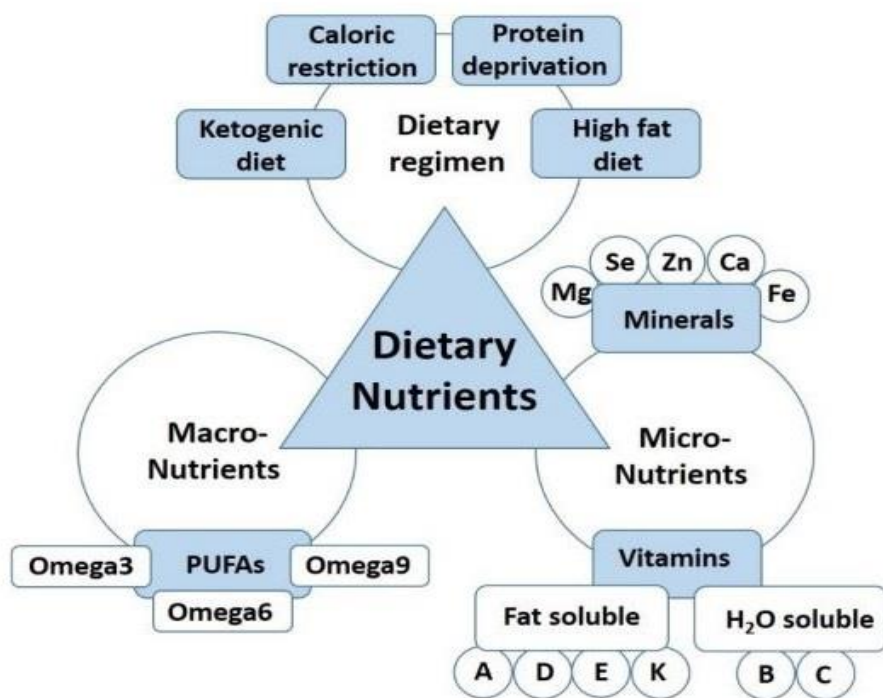
Magnesium  $Mg^{2+}$  has important roles in the brain, heart, bone, blood, skeletal muscle and basically every organ in the body (El Soury et al., 2021). “Increased nerve regeneration in  $Mg^{2+}$  treated animals was also accompanied by an improvement in sciatic nerve functional index, increased compound muscle action potentials, and reduced nerve conduction latency” (El Soury et al., 2021). Magnesium along with protein, phosphorus, potassium, and fluoride are involved with bone health (Turnagöl et al., 2021). Magnesium is found in pumpkin seeds, chia seeds, almonds, cashews, spinach, black beans, soy milk, edamame, peanut butter, brown rice, and salmon. If you choose to follow a supplement route, those will cost somewhere between \$10 to \$20.

### Iron

Iron Fe is important for myelin and neurotransmitter production in your nervous system (El Soury et al., 2021). Iron promotes oxygen transport and the creation and repair of DNA (El Soury et al., 2021). Foods that contain iron are bread, spinach, silver beet, broccoli, sweet potatoes, peas, baked beans, lentils, and chickpeas. A supplement is a great way to go with a cost of about \$10 to \$20.

### Selenium

Selenium Se is an antioxidant that partakes in the central nervous, male reproductive, endocrine, and cardio systems (El Soury et al., 2021). Selenium also works with muscle and immune cell functions (El Soury et al., 2021). Selenium can be found in foods like beef, chicken, turkey, whole wheat bread, Brazil nuts, beans, and lentils. A supplement for selenium would cost anywhere from \$5 to \$15.



The dietary nutrients affecting nerve regeneration.

Fig 3. Visual representation of balanced diet. ( El Soury et al., 2021, Fig 1)

#### Dietary strategies and metabolism

Dietary strategies involve many aspects in conjunction with the nutrient you choose to take. "Dietary nutrients are essential for life and the maintenance of proper body functions; macronutrients (proteins, fats, and carbohydrates) provide the major sources of energy needed, while micronutrients (vitamins and minerals) play a central role in metabolism, e.g., through providing essential cofactors for enzymatic functions as well as the maintenance of specific tissue function" (El Soury et al., 2021). When it comes to before training or competition, an athlete on a diet high in carbohydrates (10g/kg/day) showed more power output than an athlete

on a diet of lower carbohydrate intake (5g/kg/day) (Kim et al., 2020). Whey protein is popular among athletes because of its fast absorption. (Kim et al., 2020).

Whey protein is considered the highest-quality protein source, with more than 50% of the amino acid composition coming from EAAs and 2.7 g of leucine in a common dose (25 g of protein). Whey protein isolate and concentrate are the most common forms of whey protein. (Smith-Ryan et al., 2020). The isolate is more highly filtered than the concentrate, resulting in greater protein content per dose and little to no fat and lactose, making it more tolerable for individuals with lactose intolerance (Smith-Ryan et al., 2020). Whey protein is a fast-digesting protein source that rapidly increases EAA availability in the blood. (Smith-Ryan et al., 2020). This makes it an ideal source of protein before and after exercise and rehabilitation. In contrast, casein protein (a milk-based protein) is slower to be digested (Smith-Ryan et al., 2020). Research suggested that consuming 30 to 40 g of casein before bed enhanced overnight muscle protein synthesis (Smith-Ryan et al., 2020).

For recovery, immediately after exercise, protein should be consumed (Kim et al., 2020). "From Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine, in cases of energy restriction or reduction of physical activity as it happens as a result of an injury, the increased protein intake of up to 2.0 g/kg/day or more, fractionated throughout the day, can be beneficial to prevent the loss of fat-free mass" (Quintero et al., 2018). "Diets emphasizing fewer carbohydrates (ie, approximately 40%) or a 2:1 carbohydrate: protein ratio (eg, 260 g carbs and 130g protein), have been shown to promote positive changes in body composition" (Smith-Ryan et al., 2020). "Nutrients known to promote healing following an injury, including vitamins C, D, and E, creatine, glycine, polyphenols, flavonoid, and branched chain amino acids (BCAAs)" (Turnagöl et al., 2022). "The proliferation and differentiation of SCs can be modulated by nutrients such as dietary carbohydrate, vitamin D, and Vitamin E, however, their effect varies depending on the origin of muscle type" (Isesele et al., 2021). The long-term intake of omega-3 fatty acids enhances anabolic sensitivity to amino acids; thus, it may be beneficial to the injured athlete" (Papadopoulou, 2020). "In the last four decades, evidence has been provided that in humans and mammals, the dietary supply of polyunsaturated fatty acids (PUFAs) has neuroprotective effects attenuating the neuronal damage after a traumatic or chemical nerve injury" (El Soury et al., 2021).

The Ketogenic diet which forces the body to digest fat by the intake of protein that is minimal but enough, a reduction in carbohydrates, and an increase in fat consumption (El Soury et al., 2021). Caloric restriction (CR) is a dietary reduction of energy intake. "CR associated with adequate nutrition has been shown to extend health span and lifespan in rodent and primate models through metabolic and molecular adaptation and retardation of molecular damage accumulation" (El Soury et al., 2021). A diet to stay away from, and not to be confused with the Ketogenic diet is a high fat diet, which is actually a problem in developed countries (El Soury et al., 2021). A high fat diet introduces a variety of health problems including prediabetes, obesity, hyperglycemia, and peripheral neuropathy (El Soury et al., 2021). "Humans consume greater amounts of processed food in the modern era, and food processing steps such as heating, freezing, seasoning, coloring, and sterilizing with antibiotics modify the nutritional value of food as well as impact the gut microbiome" (Cheng et al., 2021).

Another diet strategy known as Mediterranean diet is one with high in "monounsaturated fatty acids from olives, fruits, vegetables, and whole grains, low consumption of red meat and moderate use of red wine can enhance antioxidant defenses and improves the lipid oxidation" (Quintero et al., 2018). The consumption of Mediterranean diet and extra virgin olive oil can help to attenuate and overcome inflammation after injury in the articular cartilage, preventing osteoarthritis" (Papadopoulou, 2020).

Also, part of dietary strategies would include fasting and fasting mimicking. "Three prototypical regenerative diets include (1) CR that reduces caloric intake for an extended period of time (i.e., months to years), (2) fasting and fasting-mimicking interventions that deprive food or macronutrients (i.e., carbohydrates, proteins, and fats) for a short period of time (24– 48 h) and that can include cycles of fasting and refeeding, and (3) the ketogenic diets that emulate the metabolic changes noted in CR and fasting without reduced calorie intake" (Cheng et al., 2021).

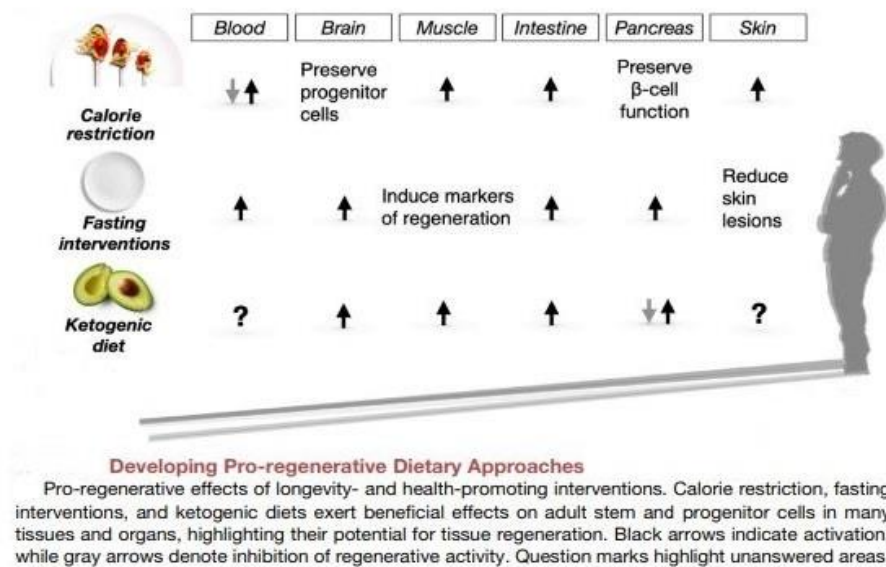


Fig 4. Types of diets (Cheng et al., 2021, Fig 2)

"A dietary strategy should be tailored to the athlete's needs, considering amounts, frequency, type and, most of all, protein quality" (Papadopoulou, 2020). "The Institute of Medicine Committee on Nutrient Composition of Rations for Combat Operations recommended that nutrients should be provided as whole foods first, followed by fortified foods and a multivitamin dietary supplement" (Smith-Ryan et al., 2020). "Rich data support practical nutritional recommendations for reducing surgical complications, minimizing muscle loss during immobilization, and maximizing return to play" (Smith-Ryan et al., 2020). "When choosing dietary supplements, purchasing products that have been subjected to third-party testing to verify product contents and rule out contaminants is advised" (Smith-Ryan et al., 2020). "Athletic trainers, physical therapists, and other health care professionals should provide basic nutritional recommendations during rehabilitation, discuss the timing of meals with respect to therapy, and refer the patient to a registered dietitian" (Smith-Ryan et al., 2020).

Nutrition points for the recovery of rowing athletes.

Components	Nutrition Points
Refueling	<ul style="list-style-type: none"> <li>The most important goal is the carbohydrate intake for glycogen replenishment.</li> <li>Timing of carbohydrate intake: Immediately after the training or competition (the sooner the better).</li> <li>Type of carbohydrate intake: High glycemic index (GI) carbohydrate.</li> <li>Carbohydrate form: Liquid or solid form or as a meal or a snack.</li> <li>Amount of carbohydrate intake: 1.2g/kg.</li> </ul>
Rehydration	<ul style="list-style-type: none"> <li>The most important goal is ensuring sufficient fluid intake.</li> <li>Timing of fluid intake: Immediately after the training or competition.</li> <li>The weight loss after the training reflects the loss of fluid (Monitoring of weight change is required).</li> <li>Amount of fluid intake: 1.5-times the amount of weight loss.</li> <li>Sports drinks or food with sodium (Na+) and water can be consumed.</li> </ul>
Repair	<ul style="list-style-type: none"> <li>The most important goal is to facilitate muscle protein synthesis.</li> <li>Protein type: Whey protein (easy digestion and absorption, rich in essential amino acids and leucine).</li> <li>Amount of protein intake: From about 20–25 g to 40 g; relative value of the intake is about 0.3–0.4 g/kg.</li> <li>Protein intake distribution: Intake of every 3–5 h is recommended.</li> <li>To promote recovery, approximately 40 g of casein protein can be consumed 30 min before sleep.</li> </ul>

Fig 5. Suggested what and when intake according to phase. (Kim et al., 2020, Table 3)

An important mention must be made of whom you get advice from. Anyone can make claims, and until they have a certification you should consult a medical doctor or someone with a certification to give nutritional advice. Taken from The New York State Education Department (“SED”) Office of the Professions (“OP”) website: "Certification is not required to perform nutritional counseling in New York, but only individuals certified by the New York State Education Department may use the certified dietitian/nutritionist titles."

In addition, this paper contains a lot of information which is true to the best of my knowledge, but discoveries are always made, and things change. Items discussed in this paper may not provide the same outcomes because of an endless number of variables. You should always consult a medical doctor.

### My own experience with nutrition

Individuals who want to increase their physical well-being or have suffered an injury like me may decide on taking any one or combination of nutrients I listed above or have not mentioned. Will that person see results? I would hope so, but attention must be given not only to what the person should incorporate into their diet, but how it should be taken. Diet strategy is just as important to promote the healing from an injury or the general health of the body.

The first strategy is what I would take. I mentioned several nutrients above, but listing everything would be outside this paper's scope. I have spoken about protein substantially so I will use it as an example to convey my points. What was my go-to protein? I have listed Whey as being the best, and that is what I use. I have taken a notice to Soy protein because it has a nice amino acid profile, but I gravitate to Whey

Next strategy, how much do I plan to take? I currently take it for general health, so I take one serving or two. If I wanted to be a body builder, I would take one gram of protein per how many pounds I weigh. If I wanted to deal with an injury, I would increase my intake to compensate for my body's additional need because of regeneration. I would do a 50% increase from my general health amount, but every injury and person are different.

What about the quality? Going back to Whey protein, would I choose concentrate or isolate? Whey protein concentrate is exactly what the name implies. It is made from milk without most of the other stuff that makes it milk and you are left with a mostly protein product. Suppose I was lactose intolerant. Then this level of quality may not be good enough for me. Then I would want Whey protein isolate. Isolate has little to no lactose and offers a higher amount of protein per scoop. A higher amount of protein per scoop would also be a desirable choice if I wanted to be a body builder.

What about the source? I have noticed different name brands create their own cocktail of protein shake. One version of Whey protein may not agree with me, but another will. I do not want all the additives. I would choose a simple straight forward product that has just Whey protein in it.

When will I take the protein? Do I plan to take it multiple times every day? It is more beneficial to consume the protein throughout the day to provide a steady stream of nutrition the

body can count on. I can have a protein shake before or after food and even in place of a meal with weight loss in consideration. I can take the protein after exercise to help my muscles recover. With that in mind, the temperature you consume the protein makes a difference too. The hotter the liquid, the faster it will go through your body. I can take it cool as a meal supplement or take it warm or hot after a workout, so it rushes to the nutritional needs of my body.

When I was an athlete and preferred to speed up an injury as soon as it happened, I considered the prolonged intake approach. Daily consumption not only supplies the body with a steady flow but the body stores an amount so it can use it immediately when it needs it. The amount stored depends on the substance taken. Sometimes when I engaged in exercise, I preferred to take protein with other supplements working on the fact that groups of vitamins or minerals provide a more positive effect.

For exactly what is right for you, I recommend a certified dietician or nutritionist to provide a diet catered to you for the best regeneration or overall health. If you are new to the protein world and find the taste intolerable, you can always add sugar. Many supplements come preflavored, but the taste is still something that needs to be acquired. It is preferred not to have sugar though. Sugar has a nasty trait of taking nutrition with it when it leaves your body. Consideration should be given to what form you will take your supplement in. You can use protein in the powder form, but know it comes in pill form, and meal replacement bars.

After reviewing a number of peer-reviewed articles, there is no doubt that a positive relationship exists between nutritional supplementation strategies and the body's ability to regenerate after injury. Now that this has been established, why is it not standard protocol for doctors to implement nutritional strategies among the patients they treat?

## Chapter 5: Conclusions

Does a positive relationship exist between nutritional supplementation strategies and the body's ability to regenerate after injury? The research indicates an undeniable yes. A positive relationship does exist between nutritional supplementation strategies and the body's ability to regenerate after injury. The papers reviewed also showed a decrease in future injuries. It has been realized through the substantial proof that a positive relationship is present between nutritional supplementation strategies and recovery after exercise. Furthermore, it has been established from ample proof that a positive relationship exists between nutritional strategies and the general health of a person. With the evidence demonstrating an important connection between dietary intake and human health, questions arise like why is nutrition not interwoven into a person's medical visit more, and why is it not accessible to people?

We started with regeneration after injuries and continued to include prevention of future injuries, then with recovery after exercise and finally overall good health all from incorporating nutritional strategies. With that I wonder why do doctors not prescribe certain foods as much as they prescribe drugs? Drugs may not be composed of the same nutrients found in foods or vice versa but foods still promote good health. One of the problems is with education in the medical field when becoming a medical doctor. According to the Chicago Tribune 'Less than half of U.S. medical schools offer courses in nutrition' (Sadick, 2018). Doctors are not taught about nutrition to the extent of instead of prescribing vitamin A, a doctor could say to eat more apples for example.

A good point to consider is 'neglect of this topic has done harm and led to a very poor understanding of the underlying root causes of many diseases such as poor-quality food' (Millard, 2023). Consuming a nutrient rich diet will actually prevent health problems to begin with. It is a cycle where because a person is not educated by the doctor on what foods to eat or the importance of a healthy diet, that person slides backwards into taking more drugs and overlooking what they consume. Proper nutrition is powerful, for example "there's also complexity around how certain foods interact negatively with medications, potentially

preventing a drug from working the way it should or worsening the side effects" (Millard, 2023). Not only can food go head-to-head with prescription drugs, but a doctor should be nutritionally educated for the reason of the negative food and drug interactions.

Steps are being taken to correct this life affecting situation. The legislature in New York has passed legislation to create a "Nutrition Education Resource Library" for physicians and the Doctors Group is urging Governor Hochul to sign it into law (Physicians Committee for Responsible Medicine, 2023). Under this bill, the New York State Department of Health (NYSDOH) would have to share with physicians a database they maintain about training in nutrition and continuing medical education coursework (Physicians Committee for Responsible Medicine, 2023). With this, we will see a decline in diet-related diseases such as heart disease or diabetes. This database created by the NYSDOH would also include 'resources regarding racial and other disparities in health outcomes' (Physicians Committee for Responsible Medicine, 2023). That is interesting because suppose doctors educate themselves in the field of nutrition and correctly advise a patient to eat more avocados for example, would the health insurance cover it?

People are barely making it financially and eating well is outside a drug prescription, or is it? What about people on Medicaid or Medicare? Considering the lack of funds it takes to qualify for those plans, will adjustments be made to encompass this new change in the medical field? I would think it would have to. After the reason of human life, for the reason of cost. It is cheaper to prevent an illness than to try to fix it after it occurs. With that said, I can totally see a world where a person gets apples, bananas, and spinach through the pharmacy. What about people who live in what are known as food deserts? Outside the reach of a supermarket or other market that has better nutritional options? For them it is cheaper to buy chips at the local candy store than to drive or take the bus to a supermarket where healthier choices are available. Would a doctor's prescription be filled out at a hospital and the patient walk away with a bag full of fruits and vegetables? That is outside the scope of this paper, and additional research should be done making connections between healthy food and people who are distant from access to that lifesaving nutrition and reside in poverty.

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## Glossary

**Angiogenesis** - Development of new blood vessels.

**CNS** - Central nervous system.

**Certified Dietitian/Nutrition** - In New York, a person must have a bachelor's degree in dietetics/nutrition with a minimum of six months of acceptable experience or an associate's degree in dietetics/nutrition with at least eight years of acceptable experience and have also passed a NYS approved licensing examination.

**Calorie Restriction Diet (CR)** - A diet that reduces calorie intake (about 500) for an extended period of time.

**Demyelinating Disease** - Damage to the Myelin sheath that surrounds nerve fibers in your brain, optic nerve, and spinal cord.

**Electrophysiological** - Electrical phenomena associated with a body part.

**Fasting Mimicking Diet (FMD)** - low-calorie (>50% reduced) with sugars, protein, and unsaturated fats, was developed to emulate a fasting.

**Health Coach** - can offer general advice about nutrition and healthy eating habits.

**Hematopoietic Stem Cells (HSC)** - Primitive cells that can develop into all types of blood cells.

**High Fat Diet (HFD)** - A diet consisting of at least 35% of total calories is consumed from fats, both unsaturated and saturated.

**Histological** - Study of the structure of cells and tissue seen under a microscope.

**IU** - International Unit

**Ketogenic Diet** - Forces the body to digest fat by the intake of protein that is minimal but enough, a reduction in carbohydrates, and an increase in fat consumption.

**Mediterranean Diet** - Consumption of monounsaturated fatty acids from olives, fruits, vegetables, and whole grains, low consumption of red meat and moderate use of red wine. Can enhance antioxidant defenses and improves the lipid oxidation.

**Mvoblasts** - The mononucleate precursor cells of skeletal muscle, can differentiate to form multinucleated muscle fibers capable of muscle contraction.

**Neuropathic Pain** - Nerve pain

**Nutritionists** - Provide guidance, advice, and support for people with nutritional needs, but usually cannot provide medical nutritional counseling or diagnose or treat illnesses.

**Oligodendrocytes** - Myelinating cells of the CNS that allow the fast and efficient transfer of neuronal communication through the myelination of axons.

**Sarcopenia** - A condition that leads to the loss of muscle mass and, subsequently, the loss of muscle function and strength.

**Satellite Cells (SC)** - Satellite cells are precursors to skeletal muscle cells.

**UVB** - Ultraviolet radiation with a range of 280–315 nanometres.

**Vitamin D2** - From plants.

**Vitamin D3** - Made by humans and found in fatty fish.

### Dedication

I would like to dedicate this paper to an absolutely wonderful person. Professor Mara Toby Horowitz. I am battling a number of stresses and ready to give up on my schoolwork, but this professor came to my rescue. It motivated me to complete this last task required so I could graduate. She has my eternal gratitude.