



NICOLAUS COPERNICUS
UNIVERSITY
IN TORUŃ



Quality in Sport. eISSN 2450-3118.

Journal Home Page

<https://apcz.umk.pl/QS/index>

SIM, Aleksandra, MIODUSZEWSKA, Joanna, ROT, Paweł, PONIEWOZIK, Piotr, DZIUBA, Natalia, PERNAL, Maja, ROGUSKA, Zofia, ZUZAK, Andrzej Paweł, PONIEWOZIK, Paweł and GRABOWSKI, Krzysztof. The Effects of Protein Supplement Intake in Adolescents - Impact on Health and Development. Quality in Sport. 2026;53:70238. eISSN 2450-3118. <https://doi.org/10.12775/QS.2026.53.70238>

The journal has been awarded 20 points in the parametric evaluation by the Ministry of Higher Education and Science of Poland. This is according to the Annex to the announcement of the Minister of Higher Education and Science dated 05.01.2024, No. 32553. The journal has a Unique Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).

Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych). © The Authors 2026.

This article is published with open access under the License Open Journal Systems of Nicolaus Copernicus University in Toruń, Poland. Open Access: This article is distributed under the terms of the Creative Commons Attribution Noncommercial License, which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited. This is an open access article licensed under the terms of the Creative Commons Attribution Non-commercial Share Alike License (<http://creativecommons.org/licenses/by-nc-sa/4.0/>), which permits unrestricted, non-commercial use, distribution, and reproduction in any medium, provided the work is properly cited.

The authors declare that there is no conflict of interest regarding the publication of this paper.

Received: 25.03.2026. Revised: 30.03.2026. Accepted: 30.03.2026. Published: 05.04.2026.

Short Article

The Effects of Protein Supplement Intake in Adolescents - Impact on Health and Development

Aleksandra Sim

Medical University of Lublin, Aleje Raławickie 1, 20-059 Lublin, Poland

misardnaskela@gmail.com

<https://orcid.org/0009-0001-6475-4595>

Joanna Mioduszevska

Medical University of Lublin,

Aleje Raclawickie 1, 20-059 Lublin, Poland

asia.mioduszevska01@gmail.com

<https://orcid.org/0009-0001-1024-1217>

Pawel Rot

Medical University of Lublin,

Aleje Raclawickie 1, 20-059 Lublin, Poland

pawel_rot@outlook.com

<https://orcid.org/0009-0004-4140-4463>

Piotr Poniewozik

Medical University of Lublin, Aleje Raclawickie 1, 20-059 Lublin, Poland

piotr.poniewozik01@gmail.com

<https://orcid.org/0009-0001-6350-4981>

Natalia Dziuba

Medical University of Lublin, Aleje Raclawickie 1, 20-059 Lublin, Poland

nat.dziuba@gmail.com

<https://orcid.org/0009-0002-4719-9208>

Maja Pernal

Medical University of Lublin, Aleje Raclawickie 1, 20-059 Lublin, Poland

peralmaja@gmail.com

<https://orcid.org/0009-0003-9616-2361>

Zofia Roguska

Medical University of Lublin, Aleje Raclawickie 1, 20-059 Lublin, Poland

zosia.roguska@gmail.com

<https://orcid.org/0009-0007-8588-2784>

Andrzej Pawel Zuzak

Medical University of Lublin, Aleje Raławickie 1, 20-059 Lublin, Poland

andrzejzuzak1@gmail.com

<https://orcid.org/0009-0008-6578-1457>

Pawel Poniewozik

Medical University of Lublin, Aleje Raławickie 1, 20-059 Lublin, Poland

poniewozikpawel01@gmail.com

<https://orcid.org/0009-0006-2057-2219>

Krzysztof Grabowski

Dr. Tytus Chałubiński Radom Specialist Hospital, Adolfa Tochtermanna 1 Street, 26-610 Radom, Poland

krzysztofgrabowski444@gmail.com

<https://orcid.org/0009-0004-1482-7188>

Abstract

Background: Over the past two decades, adolescent protein supplement consumption has surged, driven by social media "fitness culture" and evolving standards of muscularity. Despite protein's role in pubertal development, there is a significant shift toward prioritizing processed supplements over whole-food sources, particularly among young males and athletes lacking professional oversight.

Aim: This study synthesizes clinical evidence and position statements to evaluate the prevalence, efficacy, and safety of protein supplementation in adolescents, focusing on physiological risks and the correlation with disordered eating or muscle dysmorphia.

Material and methods: The study reviews data from major health organizations regarding protein requirements for active versus sedentary youth and the efficacy of whey protein compared to whole foods.

Results: Clinical evidence shows that while whey protein may marginally improve aerobic capacity, it does not enhance muscle mass or anaerobic power more effectively than whole-food protein. Significant concerns include supplement contamination, heavy metals, renal stress, and acne exacerbation via IGF-1 stimulation. A "gateway effect" also correlates excessive intake with disordered eating and body dysmorphia.

Conclusions: Health organizations emphasize a "food-first" approach, recommending supplements only when dietary intake is insufficient. Educational interventions are vital to mitigate the risks of unsupervised supplement use in youth.

Key words: protein supplements, adolescent health, sports nutrition, whey protein, body dysmorphia.

1. Introduction

In the past few years, the global sports nutrition supplement market has expanded dramatically, with protein supplements representing the most consumed category among young people willing to enhance athletic performance or modify body composition [1, 2]. Adolescence represents a critical developmental period characterized by rapid physical growth, hormonal changes, and the establishment of long-term health behaviors [1, 3]. During this time, protein requirements are elevated compared to adulthood to support growth, tissue synthesis, and pubertal development, particularly for those engaged in intense physical training [4, 5]. Understanding the evidence base surrounding adolescent protein supplement use is essential for healthcare providers, coaches, parents, and young people themselves to navigate risks such as heavy metal contamination or dermatological complications [6, 2]. This paper synthesizes current research on physiological considerations, potential benefits and risks, and evidence-based recommendations for protein supplementation in the adolescent population.

2. Methodology

This research was conducted across four primary electronic databases: PubMed/MEDLINE, Scopus, Google Scholar, and the Cochrane Central Register of Controlled Trials. To capture the most relevant data, a combination of Boolean operators and MeSH (Medical Subject Headings) terms were used.

3. Prevalence and Patterns of Use

Research consistently demonstrates that protein supplement use among adolescents is widespread and increasing. Studies from multiple countries indicate that between 12% and 40% of adolescents report current or previous protein supplement use, with significantly higher prevalence among males, competitive athletes, and adolescents engaged in structured weight training [1, 7, 8]. A study examining Australian adolescent boys showed that muscle-building supplement use was significantly associated with participation in weight lifting and sports engagement [9]. Users demonstrated greater concern about muscularity and body composition than most of same-aged individuals [9, 10]. Notably, many adolescent users report initiating supplement use based on peer recommendations or social media influence rather than guidance from qualified nutrition professionals [11, 12, 13].

4. Physiological Considerations in the Developing Athlete

Adolescent protein requirements differ from adult needs due to the demands of growth and development. The International Society of Sports Nutrition (ISSN) clarified that for adolescent athletes, the protein requirement is not static [14]. It fluctuates based on training volume, caloric balance, and the specific stage of pubertal development [4, 15]. While the Recommended Dietary Allowance (RDA) for the general adolescent population ranges from 0.85 to 1.0 g/kg/d [1], the ISSN and Kerkisick et al. (2018) provide evidence that active adolescents require between 1.2 g/kg/d and 2.0 g/kg/d, making it possible to support tissue synthesis and pubertal development [14, 4]. During puberty, Growth Hormone (GH) and Insulin-like Growth Factor 1 (IGF-1) concentrations are naturally elevated, which creates a highly anabolic environment [6, 3]. Research suggests that muscle protein synthesis can reach maximal stimulation at protein intakes of approximately 0.25 to 0.4 grams per kilogram per meal [14]. For adolescents already consuming adequate dietary protein distributed across multiple meals, supplemental protein may offer limited additional benefit due to the "muscle full" effect [16]. However, the body is no longer able to use additional amino acids for muscle building, leading instead to increased oxidation and metabolic waste [15, 17].

4.1. Potential Benefits and Efficacy

Research examining whey protein supplementation in adolescent soccer players demonstrated improvements in lean body mass and certain aerobic parameters (e.g., VO₂ max) compared to placebo [18]. However, these studies typically involve athletes already engaged in elite-level training, and the results may not always translate to recreational users [18, 19]. The convenience factor of protein supplements may benefit adolescent athletes facing

practical barriers to adequate nutrition, such as grueling school schedules and training commitments [11, 12]. In these specific circumstances, whey protein—which offers rapid digestion kinetics and high leucine content—may serve as a practical adjunct to recovery when whole food options are unavailable [14]. Furthermore, Kerksick et al. (2018) suggests that certain amino acids in protein supplements (like Alpha-lactalbumin) are precursors to serotonin [4]. These findings create a hypothesis that the supplements may support better sleep quality and cognitive "re-set" in stressed adolescent students who are balancing school duties with demanding sports. Beyond the general high protein content of supplements, recent literature has further clarified the "Leucine Trigger" hypothesis as a primary driver of Muscle Protein Synthesis (MPS). Vasconcelos et al. (2024) highlight that because adolescents experience a significantly higher rate of whole-body protein turnover compared to adults, the speed of amino acid delivery is a critical factor in initiating anabolic signaling [15]. Specifically, a rapid "spike" in serum leucine concentrations is required to activate the mammalian target of rapamycin complex 1 (mTORC1) pathway. In this physiological context, the rapid digestion kinetics of liquid whey protein isolates provide a distinct metabolic advantage over solid whole-food sources like eggs or meat [4, 15]. By causing a faster rise in blood leucine levels, these supplements may hit the "anabolic threshold" more effectively within the 30–60 minute post-exercise window, optimizing the recovery stimulus in the maturing endocrine system. Additionally, research highlights that intense training can create an "open window" of immunosuppression in adolescents. Protein supplements, particularly those rich in immunoglobulins and lactoferrin that are naturally found in high-quality whey, can support the mucosal immune system. Whey protein is a rich source of the amino acid cysteine, which is the rate-limiting substrate for the synthesis of glutathione—the body's master intracellular antioxidant [15, 18]. Since adolescent athletes experience high levels of oxidative stress during competitive seasons, maintaining glutathione status via targeted protein intake may mitigate the inflammatory "spike" that often precedes illness. This may help in reduction of the incidence of Upper Respiratory Tract Infections (URTIs) in youth athletes who are undergoing periods of heavy training loads or "overreaching" [5, 8]. However, it is important to note that these benefits are highly dependent on the processing method of the supplement. Research indicates that "ion-exchange" whey isolates often strip away these delicate subfractions, whereas "cold-processed" or "cross-flow microfiltered" concentrates better preserve the immunoglobulins necessary to provide these clinical immune benefits [18, 17]. Therefore, the potential reduction in URTI incidence observed in some youth cohorts is not a universal feature of all protein powders, but rather a result of the specific bioactive profile of high-grade dairy proteins [8, 6]. Protein supplements may play a strategic role in the preservation of Lean Body Mass (LBM) when adolescents face the unique physiological stress of a caloric deficit. In "aesthetic sports" (such as gymnastics, figure skating, or diving) or "weight-class sports" (including bodybuilding, wrestling, or judo), young athletes frequently undergo periods of intentional weight reduction to meet competitive requirements [5, 19]. During these "weight cuts," the adolescent body is at a heightened risk of entering a catabolic state, where it may break down endogenous muscle tissue to meet energy demands. Nagata et al. (2020) and Jäger et al. (2017) provide evidence that increasing protein intake to the upper end of the recommended range (up to 2.0 g/kg/d) during restricted energy intake helps in the preferential preservation of Skeletal Muscle Mass (SMM) while the body oxidizes adipose tissue for fuel [14, 5]. This "protein-sparing" effect is critical for the developing athlete because it prevents the significant drop in Resting Metabolic Rate (RMR)—often termed "metabolic slowdown"—that typically occurs when a growing adolescent consumes too few calories [15, 14]. Maintaining a higher protein-to-calorie ratio via high-quality supplements can sustain the Thermic Effect of Food (TEF) and ensure that the hormonal signaling for growth (GH/IGF-1 axis) is not completely suppressed by the energy deficit [5, 3]. However, the literature cautions that this should be a short-term intervention. Chronic caloric restriction combined with high-bolus protein intake can lead to "relative energy deficiency in sport" (REDs), which may impair bone mineral density and delay pubertal maturation [5, 20]. Therefore, while supplements can act as a metabolic buffer during acute weight-loss phases, they must be balanced with adequate total energy to support the long-term health and linear growth of the adolescent [3, 7]. Furthermore, the research presented in Xiong T., et al. (2023) shows statistical confirmation that high protein intake is positively correlated with linear growth in both children and adolescents. The study found that adolescents in the highest tertile of protein intake had a 54% lower risk of stunting compared to the lowest tertile [3]. Adequate protein intake was found to be a protective factor against stunting, particularly when animal protein sources were prioritized for their high bioavailability of essential amino acids [21, 3]. The amino acid profile of animal proteins (meat, dairy, eggs) more efficiently stimulates the GH-IGF-1 axis than plant proteins, which is the hormonal pathway responsible for bone lengthening [6, 3]. This positive association was most pronounced in adolescents aged 10 to 14, suggesting that high protein intake is most beneficial before the epiphyseal plates close [3].

5. Health Risks and Adverse Effects

While protein supplementation is often marketed as a benign tool for athletic enhancement, recent research highlights significant health risks and side effects specifically within the adolescent demographic. Because the

adolescent body is in a critical stage of physiological development, the impact of high-bolus protein intake and unregulated ingredients can be more pronounced than in adults.

5.1 Dermatological and Gastrointestinal Side Effects

One of the most frequently reported clinical side effects of whey protein consumption in young males is the exacerbation of Acne Vulgaris. Recent case-control studies suggest that the increase of insulin-like growth factor 1 (IGF-1) levels activates the nutrient-sensing kinase mTORC1, which in turn stimulates the sebaceous glands to increase lipid production (sebum) and promotes the proliferation of keratinocytes [18, 6]. This process leads to follicular obstruction and inflammation, often manifesting as cystic acne on the face and trunk that is notably resistant to conventional topical treatments until the supplement is discontinued [4, 6]. Furthermore, many adolescents using protein supplements report gastrointestinal distress, including bloating, nausea, and diarrhea. Commercial powders frequently include non-nutritive sweeteners (such as sucralose or acesulfame potassium) and thickening agents (like carrageenan or xanthan gum). These additives can alter the gut microbiota and increase osmotic pressure in the colon, leading to gas and discomfort [1, 15]. Additionally, many "whey concentrates" contain significant residual lactose, which can be poorly tolerated by the developing gastrointestinal tracts of certain adolescent populations [15, 17]. Consuming high-bolus doses of protein (exceeding 30–40g in a single sitting) can overwhelm the small intestine's absorptive capacity, leading to protein fermentation in the large intestine, which produces odorous gases and digestive urgency [18, 8].

5.2 Association with General Adiposity

Research by Nagel-Schreckberg et al. (2020) provides a finding regarding protein consumption: higher intakes of animal-derived protein are significantly associated with increased general adiposity in adolescents. While many young athletes use supplements containing whey (an animal protein) to decrease body fat, this large-scale study suggests that excessive animal protein intake may correlate with higher Body Mass Index (BMI) and increased fat mass over time. This divergence may be explained by the insulinotropic response. Research shows that animal proteins, particularly whey, elicit a much stronger insulin response than plant proteins. Frequent insulin spikes can promote lipogenesis and inhibit lipolysis, especially when consumed in excess of immediate caloric needs [8, 12]. On the other hand this metabolic effect might be explained by the fact that animal proteins contain a bigger amount of Branched-Chain Amino Acids (BCAAs), such as leucine. While leucine is the "trigger" for muscle growth, chronically high levels in the absence of intense physical demand have been linked to insulin resistance and altered lipid metabolism in youth [12, 22]. Plant-based protein intake did not show the same positive correlation with body fat. Furthermore, research suggests that plant based whole-foods are naturally packaged with dietary fiber and phytonutrients that slow digestion and improve satiety. In contrast, liquid protein supplements are rapidly absorbed, providing a dense caloric load with minimal impact on the body's fullness signaling, potentially leading to a positive energy balance [20, 22].

5.3 Renal Stress

There is ongoing concern regarding the long-term impact of chronic high-protein intake on adolescent renal function. While healthy kidneys can generally process increased nitrogen, the "more is better" mentality common among teenagers can lead to intakes that far exceed the recommended 1.2 to 2.0 (g/kg/day) [14]. This puts physiological stress on the kidneys and liver, particularly if the athlete is not maintaining adequate hydration. Research indicates that high-protein diets lead to glomerular hyperfiltration. While this is a normal adaptive response in healthy adults, in adolescents—whose organs are still maturing—long-term hyperfiltration may lead to increased "wear and tear" on the nephrons. In practice, it means that the nephrons physically enlarge to handle the constant workload. The delicate basement membrane of the filter is subjected to constant high-pressure flow. Over time, this mechanical stress can cause "leaks," allowing larger molecules like albumin (protein) to pass into the urine. As the nephrons are overworked, some may eventually collapse and become replaced by scar tissue (fibrosis). Since nephrons cannot regenerate, the remaining healthy nephrons must engage in compensation, creating a cycle of increasing pressure and further scarring. Research notes that while a healthy teen might not show signs of kidney failure immediately, the functional reserve of their kidneys is being depleted. As a result, later in life, they may be more susceptible to chronic kidney disease (CKD) if they encounter other stressors like high blood pressure or diabetes [15, 17].

5.4 Product Purity and Contamination Risks

A critical safety concern identified by the International Society of Sports Nutrition (ISSN) and the American Academy of Pediatrics is the lack of regulation in the supplement industry. Many products marketed for "muscle building" have been found to be cross-contaminated with:

- **Anabolic Androgenic Steroids (AAS):** Unlisted ingredients that can cause irreversible endocrine disruption in developing teens.
- **Heavy Metals:** Lead, arsenic, and cadmium have been detected in various "natural" plant-based and whey proteins products.
- **Stimulants:** Unlabeled caffeine or synephrine which can cause cardiovascular strain.

As noted in Eichner & Tygart (2016), many muscle-building supplements are enriched with unlisted anabolic steroids or pro-hormones, ensuring that the user can see "results" of training. Research shows that these hidden substances may be hepatotoxic. They may disrupt ammonia production and the urea cycle, leading to cholestasis, jaundice, and in severe cases, acute liver failure. Adolescents are particularly vulnerable, because of ongoing development of their liver enzyme pathways. As noted in the discussion of renal stress, the kidneys are the primary filtration site for metabolic waste. The introduction of heavy metals to the diet can induce oxidative stress and damage the proximal tubules, compounding the filtration disruption already caused by high-dose protein intake. Furthermore, research notes that lead, even in trace amounts, can impact cognitive function and behavioral regulation during the critical adolescent growth window. This and other heavy metals have the ability to mimic calcium in the body. In adolescent athletes with high bone turnover rates, these contaminants may be integrated into the bone matrix or interfere with proper mineralization, potentially affecting long-term skeletal health [20, 23, 2]. Since the adolescent body is more efficient at absorbing certain minerals and less efficient at detoxifying heavy metals than the adult body, the cumulative "toxic load" from daily supplement use is a significant clinical concern [15, 17].

5.5 Psychological Risks and Eating Disorder Pathology

The integration of protein supplements into an adolescent's lifestyle is frequently linked to more than just physical performance; it is often entangled with complex psychological drivers and the development of disordered eating patterns. The use of muscle-building dietary supplements (MBDS) in adolescence is a significant clinical marker for body image disturbance and "muscle dysmorphia"—a subtype of body dysmorphic disorder characterized by the obsessive belief that one's physique is insufficiently muscular [5, 10]. Research indicates that the initiation of protein supplement use is rarely an isolated nutritional choice. Yager & McLean (2020) found that muscle-building supplement use in adolescent boys is strongly correlated with higher levels of body dissatisfaction and a drive for muscularity [9]. This demographic is particularly susceptible to the "gateway" effect, where the normalized use of over-the-counter protein powders leads to an increased openness toward more dangerous performance-enhancing substances, such as anabolic steroids, as the user seeks more rapid physical changes [9, 10]. Furthermore, the research suggests that adolescents using protein and creatine products are significantly more likely to engage in "compulsive exercise," where physical activity is no longer for recreation but is a mandatory, anxiety-driven behavior to manage body shape [10, 2]. The reliance on supplements can determine a young athlete's relationship with whole foods and their understanding of sustainable nutrition. As noted in Nagata et al. (2020), healthcare providers are encouraged to use harm-reduction approaches. Because the use of these supplements is often tied to an adolescent's identity and self-esteem, abrupt prohibition can be ineffective. Instead, the literature suggests that screening for supplement use should serve as an entry point for clinicians to discuss body image, self-worth, and the psychological pressures of modern "fitness culture" [5, 12].

6. Conclusion

The evidence synthesized from current sports nutrition literature and pediatric position stands indicates that while protein is a fundamental macronutrient for growth, the widespread use of protein supplements among adolescent athletes presents significant physiological and psychological challenges. The research consistently demonstrates that most adolescents can meet their increased metabolic demands through a "food-first" approach, making concentrated supplementation largely unnecessary for the majority of this population. The findings highlight a critical intersection of risks. Physically, the adolescent body is subjected to increased renal and hepatic strain as it attempts to process protein loads that often exceed the metabolic ceiling for muscle protein synthesis. These risks

are compounded by the systemic threat of heavy metal contamination and adulteration of products with anabolic agents, both of which are common in a poorly regulated supplement market. Furthermore, the strong correlation between supplement use and body image dissatisfaction suggests that these products often serve as a gateway to disordered eating behaviors or more dangerous performance-enhancing substances. Ultimately, the consensus among organizations such as the ISSN and the American Academy of Pediatrics is that the potential for adverse health outcomes—ranging from dermatological issues like acne to long-term renal "wear and tear"—outweighs the marginal performance benefits in the adolescent demographic. Future interventions should focus on increasing risk literacy among young athletes and their guardians. Rather than relying on unregulated powders, the focus of adolescent sports nutrition should return to balanced, whole-food dietary patterns and evidence-based training supervised by qualified professionals.

Disclosure:

Author Contribution Statement

Conceptualization: Aleksandra Sim, Joanna Mioduszevska, Natalia Dziuba, Maja Pernal

Methodology: Aleksandra Sim, Zofia Roguska, Piotr Poniewozik

Formal analysis: Krzysztof Grabowski, Andrzej Paweł Zuzak

Investigation: Aleksandra Sim, Joanna Mioduszevska, Paweł Rot, Natalia Dziuba, Andrzej Paweł Zuzak, Piotr Poniewozik, Paweł Poniewozik, Zofia Roguska, Maja Pernal, Krzysztof Grabowski

Resources: Aleksandra Sim

Data curation: Aleksandra Sim, Joanna Mioduszevska, Paweł Poniewozik, Maja Pernal, Krzysztof Grabowski

Writing - rough preparation: Aleksandra Sim, Joanna Mioduszevska, Paweł Rot, Natalia Dziuba, Andrzej Paweł Zuzak, Piotr Poniewozik, Paweł Poniewozik, Zofia Roguska, Maja Pernal, Krzysztof Grabowski

Writing—review and editing: Aleksandra Sim, Joanna Mioduszevska, Paweł Rot

Visualization: Zofia Roguska, Natalia Dziuba

Supervision: Aleksandra Sim, Paweł Poniewozik, Maja Pernal

Project administration: Aleksandra Sim

All authors have read and agreed with the published version of the manuscript.

Funding statement:

No external funding was received to perform this review

Institutional Review Board Statement:

Not applicable

Informed Consent Statement:

Not applicable

Data Availability Statement:

Not applicable

Conflict of Interest Statement:

The authors declare no conflict of interest.

References:

1. **Jagim, A. R., et al. (2020).** Common Nutrition Beliefs and Practices of Adolescent Athletes. *Nutrients*. [Link: DOI 10.3390/nu12113324](https://doi.org/10.3390/nu12113324)
2. **Or, F., et al. (2019).** Taking Stock of Dietary Supplements' Harmful Effects on Children, Adolescents, and Young Adults. *Journal of Adolescent Health*. [Link: DOI 10.1016/j.jadohealth.2019.03.005](https://doi.org/10.1016/j.jadohealth.2019.03.005)
3. **Xiong, T., et al. (2023).** Associations between High Protein Intake, Linear Growth, and Stunting in Children and Adolescents. *Nutrients*. [Link: DOI 10.3390/nu15224821](https://doi.org/10.3390/nu15224821)
4. **Kerksick, C. M., et al. (2018).** ISSN exercise & sports nutrition review update: research & recommendations. *JISSN*. [Link: DOI 10.1186/s12970-018-0242-y](https://doi.org/10.1186/s12970-018-0242-y)
5. **Nagata, J. M., et al. (2020).** Adolescent and Young Adult Use of Muscle-Building Dietary Supplements: Guidance for Assessment and Harm Reduction Approaches. *Journal of Adolescent Health*. [Link: DOI 10.1016/j.jadohealth.2020.07.005](https://doi.org/10.1016/j.jadohealth.2020.07.005)
6. **Muhaidat, J. M., et al. (2024).** The Effect of Whey Protein Supplements on Acne Vulgaris among Male Adolescents: A Case-Control Study. *Dermatology Research and Practice*. [Link: DOI 10.1155/2024/2158229](https://doi.org/10.1155/2024/2158229)
7. **Knapik, J. J., et al. (2016).** Prevalence of Dietary Supplement Use by Athletes: Systematic Review and Meta-Analysis. *Sports Medicine*. [Link: DOI 10.1007/s40279-015-0387-7](https://doi.org/10.1007/s40279-015-0387-7)
8. **Silva, P. R. P., et al. (2024).** Consumption of nutritional supplements by teenagers attending gyms. *Revista Paulista de Pediatria*. [Link: DOI 10.1590/1984-0462/2024/42/2022137](https://doi.org/10.1590/1984-0462/2024/42/2022137)
9. **He, J., et al. (2017).** Muscle building supplement use in Australian adolescent boys: relationships with body image and weight lifting. *BMC Pediatrics*. [Link: DOI 10.1186/s12887-017-0920-2](https://doi.org/10.1186/s12887-017-0920-2)
10. **Ganson, K. T., et al. (2023).** Muscle-building dietary supplement use and eating disorder outcomes. *International Journal of Eating Disorders*. [Link: DOI 10.1002/eat.23862](https://doi.org/10.1002/eat.23862)
11. **Whitehouse, G., et al. (2017).** Protein supplements and adolescent athletes: A pilot study investigating risk knowledge and prevalence. *Nutrition & Dietetics*. [Link: DOI 10.1111/1747-0080.12373](https://doi.org/10.1111/1747-0080.12373)
12. **Ginter, P. M., et al. (2017).** Protein, Creatine, and Dieting Supplements Among Adolescents: Eating Disorder Risk Factors. *Frontiers in Public Health*. [Link: DOI 10.3389/fpubh.2017.00172](https://doi.org/10.3389/fpubh.2017.00172)
13. **Tugault-Lafleur, C. N., et al. (2021).** Dietary Intakes and Supplement Use in Pre-Adolescent and Adolescent Canadian Athletes. *Nutrients*. [Link: DOI 10.3390/nu13010180](https://doi.org/10.3390/nu13010180)
14. **Jäger, R., et al. (2017).** International Society of Sports Nutrition Position Stand: protein and exercise. *JISSN*. [Link: DOI 10.1186/s12970-017-0177-8](https://doi.org/10.1186/s12970-017-0177-8)
15. **Vasconcelos, Q. D. J. S., et al. (2024).** Investigating the Health Implications of Whey Protein Consumption: A Narrative Review. *Healthcare*. [Link: DOI 10.3390/healthcare12020246](https://doi.org/10.3390/healthcare12020246)
16. **Stranieri, A. (2019).** Safety and Efficacy of Whey Protein Supplementation in Teenage Athletes. *ProQuest*. [Link: URI 1023860/THESIS-STRANIERI-ANDREW-2019](https://doi.org/10.23860/THESIS-STRANIERI-ANDREW-2019)
17. **Samal, J. R., & Samal, I. R. (2018).** Protein Supplements: Pros and Cons. *Journal of Dietary Supplements*. [Link: DOI 10.1080/19390211.2017.1353567](https://doi.org/10.1080/19390211.2017.1353567)

18. **McKinlay, B. J., et al. (2020).** The effects of whey protein supplementation on athletic performance and body composition in adolescent soccer players. *APNM*. [Link: DOI 10.1139/apnm-2020-0325](https://doi.org/10.1139/apnm-2020-0325)
19. **Valbo-Jørgensen, M., et al. (2016).** Muscle-building dietary supplements: identifying patterns and side effects among adolescents. *Journal of Adolescent Health*. [Link: DOI 10.1016/j.jadohealth.2015.10.185](https://doi.org/10.1016/j.jadohealth.2015.10.185)
20. **LaBotz, M., & Griesemer, B. A. (2016).** Use of Performance-Enhancing Substances. *Pediatrics*. [Link: DOI 10.1542/peds.2016-1300](https://doi.org/10.1542/peds.2016-1300)
21. **Nagel-Schreckberg, K., et al. (2020).** Animal Protein Intake Is Associated with General Adiposity in Adolescents. *Nutrients*. [Link: DOI 10.3390/nu12102915](https://doi.org/10.3390/nu12102915)
22. **Smith, J. W., et al. (2016).** Nutritional supplement use by high school students. *JSCR*. [Link: DOI 10.1519/JSC.0000000000001423](https://doi.org/10.1519/JSC.0000000000001423)
23. **Gaurano, K. L., et al. (2021).** Use of dietary supplements by children and adolescents. *Jornal de Pediatria*. [Link: DOI 10.1016/j.jpmed.2021.10.003](https://doi.org/10.1016/j.jpmed.2021.10.003)