nutrición clínica y Dietética Hospitalaria

Artículo Original

Nutr Clín Diet Hosp. 2025; 45(2):384-393
DOI: 10.12873/452guerrero

Andean food consumption and perceived physical performance in university athletes

Consumo de alimentos andinos y el rendimiento físico percibido en atletas universitarios

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Recibido: 3/mayo/2025. Aceptado: 17/junio/2025.

RESUMEN

Introducción: Los alimentos andinos, como la quinua, la kiwicha, la maca y el tarwi, han sido consumidos durante siglos por sus reconocidas propiedades nutricionales, incluyendo altos niveles de proteínas, fibra, vitaminas y compuestos antioxidantes.

Objetivo y Metodología: El presente estudio tuvo como objetivo conocer la frecuencia de consumo de alimentos andinos de alto valor nutricional y su asociación con el rendimiento físico autopercibido en deportistas universitarios de Lima, Perú. Se aplicó un cuestionario estructurado a 108 atletas de diversas disciplinas para evaluar sus patrones de consumo y percepciones relacionadas con el rendimiento físico.

Resultados: Los hallazgos muestran una correlación positiva entre el consumo de estos alimentos y la percepción de salud, lo que sugiere una posible relevancia en el contexto de la nutrición deportiva. Se observó una diferencia por género en el consumo de quinua: el 66.7% de los hombres encuestados reportaron consumirla, frente al 51.7% de las mujeres.

Conclusiones: Promover el consumo de alimentos andinos podría contribuir a mejorar la percepción de bienestar y salud en contextos deportivos. El 94.23% de quienes los consumen semanalmente y el 100% de quienes los consumen diariamente reportaron mejoras percibidas en su rendimiento. No obstante, el análisis inferencial no mostró una asociación estadísticamente significativa entre la frecuencia de consumo y la percepción del rendimiento (p = 0.1065).

PALABRAS CLAVE

Quinua, Maca, Energía y resistencia, Percepción del rendimiento, Nutrición deportiva.

ABSTRACT

Introduction: Andean foods—such as quinoa, kiwicha, maca, and tarwi—have been consumed for centuries due to their recognized nutritional properties, including high levels of protein, fiber, vitamins, and antioxidants.

Objective and Methodology: This study aimed to assess the frequency of consumption of nutritionally dense Andean foods and their association with self-perceived physical performance among university athletes in Lima, Peru. A structured questionnaire was administered to 108 athletes from various sports disciplines to evaluate their consumption patterns and perceptions of physical performance.

Results: The findings suggest a positive correlation between the intake of these foods and perceived health, indicating their potential relevance in the context of sports nutrition. A gender-based difference was observed in quinoa consumption: 66.7% of male respondents reported consuming it, compared to 51.7% of female respondents.

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Conclusions: Encouraging the consumption of Andean foods may contribute to improved health-related perceptions in athletic contexts. Among participants, 94.23% of those who consumed these foods weekly and 100% of daily consumers reported perceived performance improvements. However, inferential analysis did not reveal a statistically significant association between consumption frequency and performance perception (p = 0.1065).

KEYWORDS

Quinoa, Maca, Energy and endurance, Performance perception, Sports nutrition.

INTRODUCTION

Andean foods have gained increasing attention in the global market, largely due to their high nutrient density and the potential health-related properties attributed to their composition. These foods are often distinguished by their content of antioxidants, dietary fiber, and essential micronutrients. Among them, Andean grains—particularly quinoa, cañihua, and kiwicha (amaranth)—are frequently highlighted for their nutritional profiles and their adaptability to various environmental conditions, ranging from coastal to high-altitude zones. Their versatility in food processing allows for the development of diverse food products with a range of sensory and functional characteristics.

Pseudocereals such as quinoa (*Chenopodium quinoa*), amaranth (*Amaranthus spp.*), chia (*Salvia hispanica*), and buckwheat (*Fagopyrum spp.*) are recognized for their richness in phenolic compounds, which have demonstrated antioxidant, anti-inflammatory, and anticarcinogenic activities in various in vitro and in vivo studies[1]. Their capacity to thrive in diverse agroecological zones, particularly the Andean region, also makes them promising candidates for sustainable food systems. These crops contribute to biodiversity conservation and may reduce dependence on synthetic agricultural inputs. In nutritional terms, their value lies in their high-quality proteins, essential fatty acids, vitamins, and bioactive compounds..

Due to their composition, these grains have been proposed as components of functional diets and may contribute to overall health when consumed as part of a balanced dietary pattern[2]. Quinoa, kiwicha, and cañihua, for example, are notable for their protein content, fiber, micronutrients, and antioxidant compounds. Bioactive peptides derived from quinoa, amaranth, and cañihua have been reported to exhibit favorable amino acid profiles. In particular, quinoa contains all nine essential amino acids and has been classified as a functional food, both for its grain and leaves, which are rich in fiber, minerals, and phytochemicals[3].

On a global scale, cereals and pseudocereals constitute a substantial source of nutrition, particularly for carbohydrates,

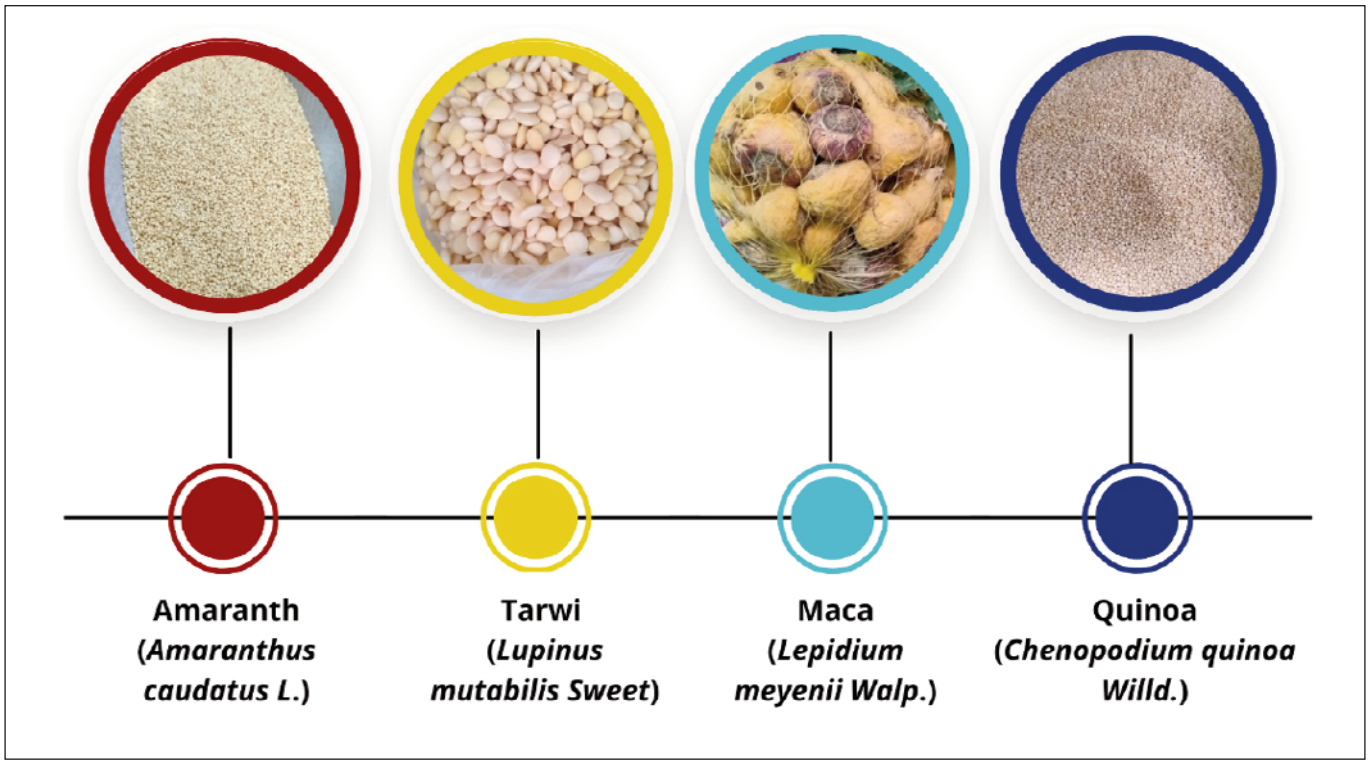

Figure 1. Andean foods

plant-derived proteins, and dietary energy. Germinated quinoa, in particular, is recognized for its enhanced levels of fiber, polyphenols, flavonoids, antioxidants[4], and amino acids, and it has been increasingly used in the development of functional food products[3]. Traditional cereals typically consist of 70–80% carbohydrates, mainly in the form of starch, and remain foundational to the global food supply[4].

Health perceptions play a central role in shaping individual behaviors, including dietary habits, physical activity levels, and rest patterns, all of which are important for both athletic performance and general well-being[2]. Although positive perceptions of health are often linked to healthier lifestyles, university students—including athletes—encounter specific challenges that may hinder optimal nutrition, such as academic demands, time constraints, financial limitations, and peer influence[5]. Furthermore, perceptions regarding diet and performance are influenced by sociocultural context, personal experience, and evolving beliefs, all of which may shape how individuals assess their own health and athletic capabilities[6]. Given the growing interest in foods commonly referred to as "superfoods"—notably Andean grains such as quinoa, cañihua, and kiwicha, as well as legumes like tarwi—due to their nutritional profiles and potential functional roles, it is relevant to investigate how these foods are perceived in relation to physical performance. However, it is essential to approach such assessments with caution, avoiding overstated claims, and to recognize the influence of confounding variables such as training intensity, overall diet quality, and individual physiology.

This study aimed to assess the frequency of consumption of Andean foods and their association with self-perceived physical performance among university athletes. It also examined differences by sport discipline and gender in order to provide a more contextualized understanding of how these foods may relate to performance perceptions. Further research involving controlled interventions and objective physiological measurements is recommended to clarify the potential role of Andean foods within sports nutrition frameworks.

Quinoa (Chenopodium quinoa Willd.)

Quinoa is a pseudocereal native to the Andean region, widely recognized for its high nutritional density and bioactive compound profile. It contains dietary fiber, essential amino acids, polyunsaturated fatty acids, vitamins, minerals, and various phytochemicals such as saponins, phytosterols, phytoecdysteroids, and phenolic compounds, which contribute to its potential functionality[7,8].

Several clinical studies have investigated its possible metabolic effects. Huang et al. (2025) reported that quinoa supplementation led to greater improvements in glycemic control than multigrain alternatives in individuals with impaired glucose tolerance (IGT), with observed reductions in postprandial glucose, HbA1c, insulin resistance, and improved lipid profiles[9], Similarly, Zeng et al. (2023) found that incorporating quinoa into the staple diet over one year was associated with improved glycemic and lipid markers, suggesting a potential role in delaying diabetes progression[10].

In individuals with non-alcoholic fatty liver disease (NAFLD), a 12-week substitution of traditional grains with quinoa was associated with improvements in liver function (measured by the controlled attenuation parameter score), HOMA-IR, and LDL-C levels, independent of changes in body weight[11]. Navarro-Perez et al. (2017) also reported that daily intake of 50 g of quinoa reduced triglyceride levels and the prevalence of metabolic syndrome in overweight and obese adults[12].

A meta-analysis by Atefi et al. (2024), which included seven randomized clinical trials involving 258 adults, found that quinoa significantly reduced fasting blood glucose in a non-linear, dose-dependent manner, although no significant effects were observed on body weight or BMI[13].

In addition to its clinical relevance, quinoa has demonstrated potential in functional food development. Repo-Carrasco-Valencia et al. (2022) highlighted its successful incorporation into gluten-free breads and protein-enriched porridges, owing to its high protein digestibility and favorable amino acid composition[14]. Its slow digestion rate may contribute to sustained energy release, supporting its consideration as a post-exercise recovery food[15].

Amaranth (Amaranthus caudatus L.)

Amaranth, sometimes referred to as the "golden crop of the future," is an Andean pseudocereal valued for its adaptability to dry and semi-arid conditions. It is nutritionally rich, containing high levels of protein, dietary fiber, vitamins A and C, calcium, iron, carotenoids, folic acid, lysine, and a range of bioactive compounds such as tocopherols, squalene, and anthocyanins[15].

Preclinical studies suggest that amaranth may exhibit anti-inflammatory, anti-diabetic, cholesterol-lowering, and prebiotic properties. In diabetic rat models, amaranth supplementation improved lipid profiles and glucose metabolism[16]. Its squalene content may provide cardiovascular support, and its naturally occurring nitrates have been associated with enhanced nitric oxide production, which could potentially improve endurance and aerobic capacity[17]. Additionally, one study reported improved cycling performance following consumption of an amaranth-based beverage, suggesting a possible ergogenic effect[15]. However, evidence in human sports nutrition contexts remains scarce, and further clinical research is warranted.

Maca (Lepidium meyenii Walp.)

Maca is a root crop endemic to the high Andes, traditionally consumed for its perceived energizing and endurance-enhancing effects. A recent systematic review and meta-analysis by Huerta Ojeda et al. (2024), which included 21 studies (16 in meta-analysis), found that maca intake significantly improved measures of physical performance, including grip strength, endurance, and reduced blood lactic acid levels[18]. These effects were attributed to bioactive compounds such as macamides, and a dose–response relationship was observed. Despite these findings, the heterogeneity of study designs and limited sample sizes call for more rigorous trials to validate these outcomes.

Kañiwa (Chenopodium pallidicaule Aellen)

Closely related to quinoa, kañiwa is an underutilized grain cultivated primarily in high-altitude regions of Peru and Bolivia (3500–4200 m). It exhibits higher protein content than many conventional cereals, along with notable amounts of lysine, dietary fiber, unsaturated fatty acids, and minerals such as iron, calcium, and phosphorus[19]. Its gluten-free nature and resilience to extreme environments make it a promising candidate for functional food development, particularly for celiac populations. Research from Universidad Nacional Agraria La Molina (UNALM) reported a high chemical score and significant oil content, rich in omega-6 fatty acids (linoleic acid), indicating potential applications in nutritional oil extraction[8].

Tarwi (Lupinus mutabilis)

Commonly known as Andean lupin, "chocho," or simply "lupine," tarwi is a legume traditionally cultivated in the highlands of Peru, Bolivia, and Ecuador. Despite its favorable nutritional profile, it remains underexploited. Its seeds contain approximately 45–50% protein and 14–24% oil—comparable to soybeans[20]. The protein fraction is particularly rich in essential amino acids such as lysine and cysteine and consists primarily of globulins and albumins, which contribute to its high biological value. Additionally, tarwi oil may act as a natural emulsifier, improving gas retention in doughs and making it suitable for gluten-free baking applications[19]. Its adaptability to high-altitude conditions and presence of bioactive compounds suggest potential applications as a functional food ingredient in both traditional and modern dietary frameworks, though further clinical studies are needed to fully assess its health impacts.

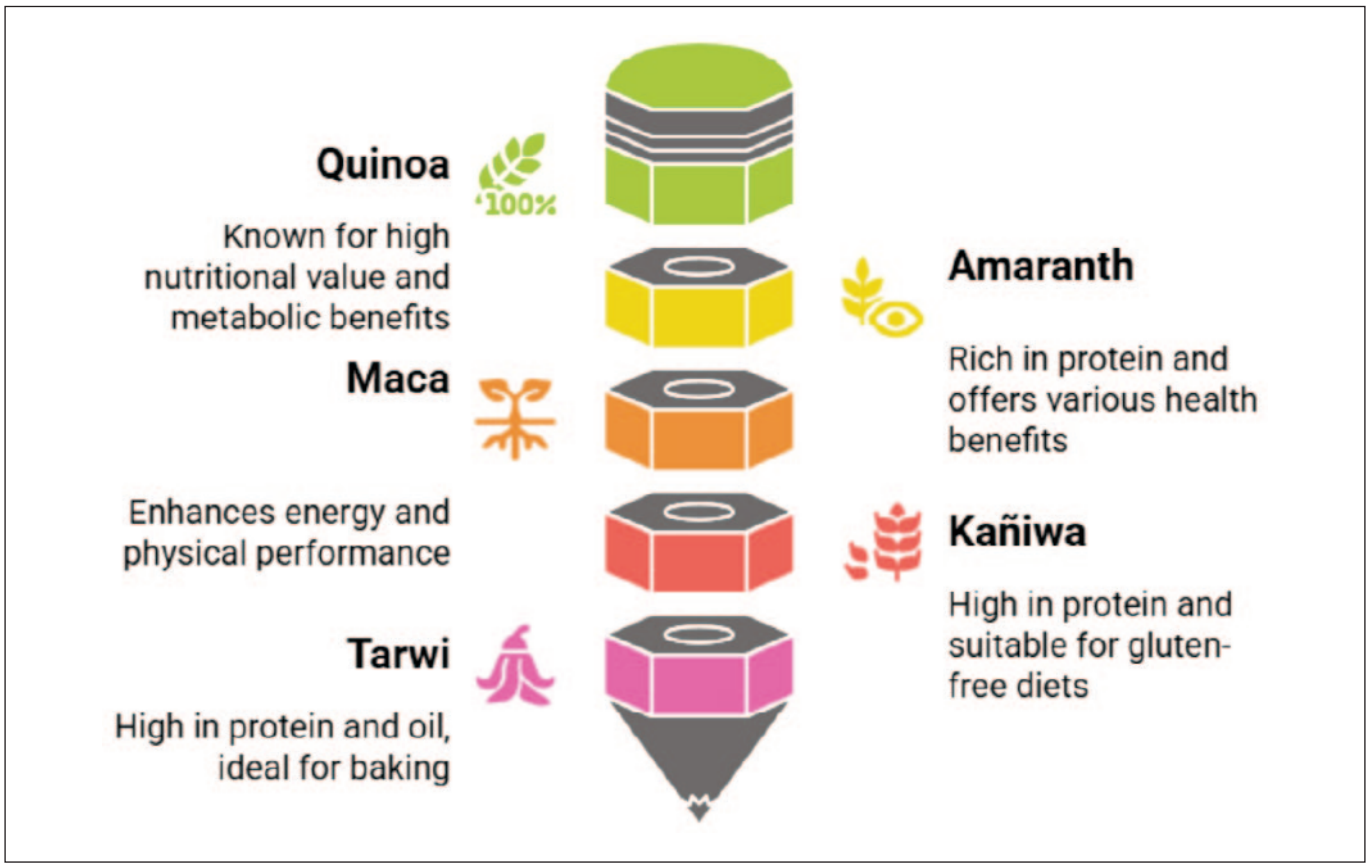

Figure 2. Nutritional characteristics

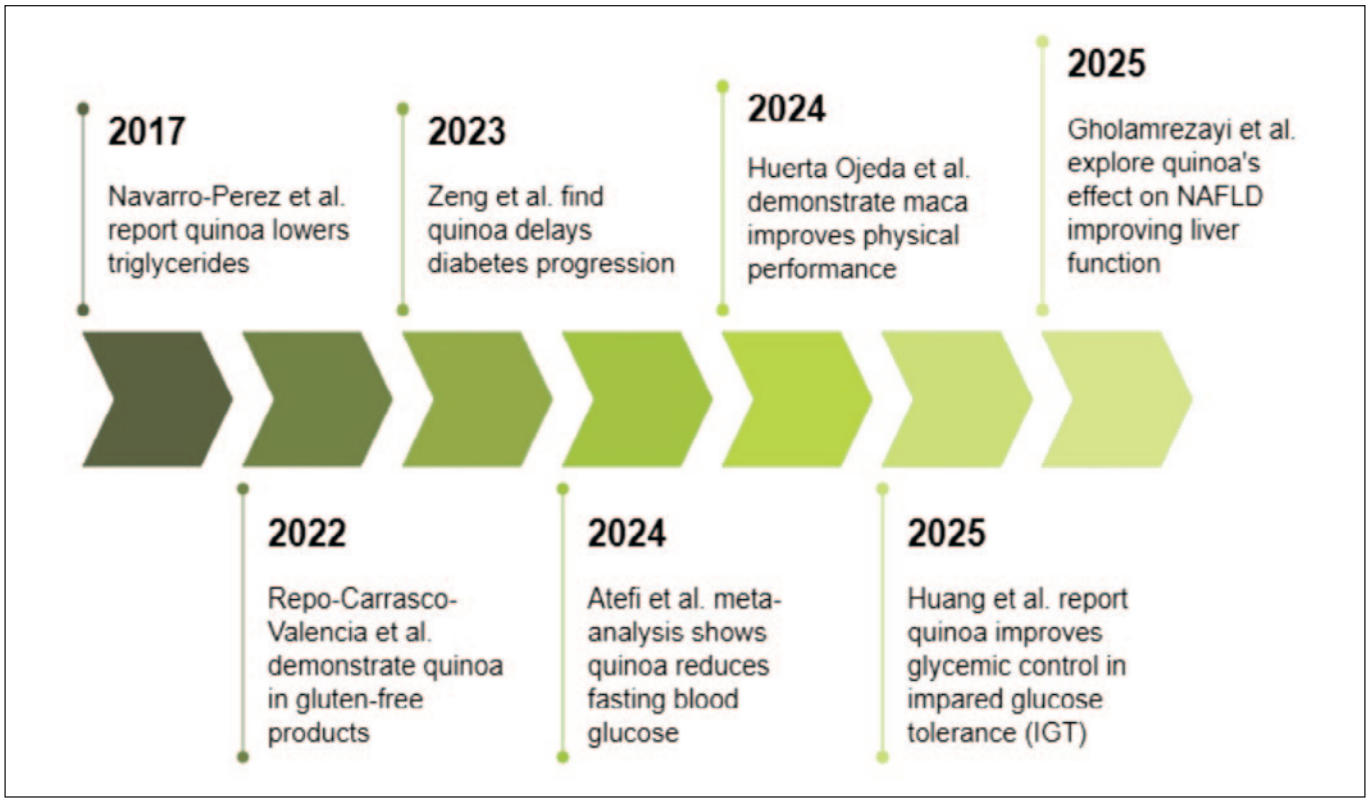

Figure 3. Key Research Milestones in Andean foods

MATERIALS AND METHODS

A 23-item questionnaire was developed to assess the frequency of consumption of selected Andean-origin foods and their association with self-perceived physical performance among university athletes. The instrument included closed-ended questions, Likert-scale items, and multiple-choice formats to capture both quantitative and qualitative aspects of dietary patterns and performance perception. Given the inherently subjective nature of self-perception measures, the instrument was carefully designed to minimize bias through neutral phrasing and the exclusion of terms such as "superfoods," which could introduce cognitive framing effects or imply exaggerated health claims. To enhance content validity, the questionnaire underwent a rigorous expert review process involving professionals with demonstrated expertise in nutrition, sports science, and psychometrics. These experts evaluated the instrument for clarity, construct relevance, and alignment with the study's objectives.

Data collection

Data collection was carried out between May 11 and May 24, 2024, through close monitoring of the athletes' training schedules. This included both morning and afternoon training sessions at two venues located in La Molina and Pachacamac, Lima, Peru. The survey was administered in person, with participants given access via a link or QR code to accommodate their time constraints. To encourage participation, energy bars were offered as an incentive.

Table 1. Research participants

Disciplines	Number of athletes
Men's Soccer	24
Ladies Basketball	16
Men's Basketball	18
Ladies Rugby	15
Men's Rugby	17
Ladies volleyball	18
TOTAL	108

Statistical Methodology

To address the research objectives, a comprehensive statistical analysis was conducted, including the generation of frequency tables and the application of inferential tests. Depending on the structure of the contingency tables, the

Chi-square test, Fisher's exact test, or the Monte Carlo method was applied. When more than 20% of the expected cell frequencies violated the assumptions of the Chi-square test, the exact Monte Carlo test was employed to provide more reliable estimates. Interpretation of results was based on the p-values and the distribution of observed frequencies across categories.

RESULTS AND DISCUSSION

The findings of this study indicate a notable presence of Andean foods in the diets of university athletes, consistent with existing literature on sports nutrition and functional foods. While a majority of athletes reported perceived performance benefits from Andean food consumption, statistical analyses did not reveal a significant correlation between consumption frequency and perceived impact on physical performance. This suggests that other factors—such as overall dietary patterns, training regimens, and individual physiological conditions—may play a more decisive role in influencing athletic performance than Andean food intake alone.

The primary objective of this study was to explore the relationship between Andean food consumption and the perception of its effects on physical performance among university athletes. The results align with the broader trend toward health-conscious eating and increased consumer interest in foods with potential nutritional benefits. These products have gained prominence due to their high nutritional density and associated health claims, a trend supported by the rising interest in functional foods designed to promote well-being through diet[21].

Among these, Andean grains—particularly quinoa—have been recognized for their adaptability and nutritional value, making quinoa a key crop in terms of both production and ex-

Table 2. Frequency of Andean food Consumption by Gender

	Man	Woman	Total	P value
Type of food				
Kiwicha	15 (57.69%)	11 (42.31%)	26 (100.0%)	0.1313
Maca	13 (76.47%)	4 (23.53%)	17 (100.0%)	
Quinua	31 (49.21%)	32 (50.79%)	63 (100.0%)	
Tarwi	0 (0.0%)	1 (100.0%)	1 (100.0%)	
All	1 (100.0%)	0 (0.0%)	1 (100.0%	
Form of consumption				
In grain	14 (53.85%)	12 (46.15%)	26 (100.0%)	0.7515
In liquid	1 (100.0%)	0 (0.0%)	1 (100.0%)	
Powder	10 (55.56%)	8 (44.44%)	18 (100.0%)	
Mixed with food	35 (55.56%)	28 (44.44%)	63 (100.0%	
Frequency of consumption				
Daily	29 (63.04%)	17 (36.96%)	46 (100.0%)	0.3162
Monthly	4 (40.0%)	6 (60.0%)	10 (100.0%)	
Weekly	27 (51.92%)	25 (48.08%)	52 (100.0%)	
Perception of performance				
No	2 (66.67%)	1 (33.33%)	3 (100.0%)	1
Yes	58 (55.24%)	47 (44.76%)	105 (100.0%	

Monte Carlo exact test was applied.

Table 3. Frequency of Andean food Consumption by Gender

	Women's basketball	Men's basketball	Men's soccer	Ladies Rugby	Men's Rugby	Ladies volleyball	Total	P value
Type of ood								
Kiwicha	3 (11.54%)	2 (7.69%)	9 (34.62%)	3 (11.54%)	4 (15.38%)	5 (19.23%)	26 (100.0%)	0.2269
Maca	2 (11.76%)	2 (11.76%)	4 (23.53%)	1 (5.88%)	7 (41.18%)	1 (5.88%)	17 (100.0%)	
Quinua	10 (15.87%)	14 (22.22%)	11 (17.46%)	11 (17.46%)	5 (7.94%)	12 (19.05%)	63 (100.0%)	
Tarwi	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	
Todos	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	
Form of consumption								
In grain	5 (19.23%)	2 (7.69%)	7 (26.92%)	4 (15.38%)	5 (19.23%)	3 (11.54%)	26 (100.0%)	0.589
In liquid	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	1 (100.0%)	
In Powder	4 (22.22%)	1 (5.56%)	5 (27.78%)	2 (11.11%)	4 (22.22%)	2 (11.11%)	18 (100.0%)	
Mixed with food	7 (11.11%)	15 (23.81%)	12 (19.05%)	9 (14.29%)	8 (12.7%)	12 (19.05%)	63 (100.0%)	
Frequency of consumption								
Daily	5 (10.87%)	7 (15.22%)	13 (28.26%)	7 (15.22%)	8 (17.39%)	6 (13.04%)	46 (100.0%)	0.5499
Monfhly	2 (20.0%)	3 (30.0%)	0 (0.0%)	1 (10.0%)	1 (10.0%)	3 (30.0%)	10 (100.0%)	
Weekly	9 (17.31%)	8 (15.38%)	11 (21.15%)	7 (13.46%)	8 (15.38%)	9 (17.31%)	52 (99.99%)	
Perception of performance								
No	1 (33.33%)	0 (0.0%)	1 (33.33%)	0 (0.0%)	1 (33.33%)	0 (0.0%)	3 (99.99%)	0.7077
Yes	15 (14.29%)	18 (17.14%)	23 (21.9%)	15 (14.29%)	16 (15.24%)	18 (17.14%)	105 (100.0%)	

Monte Carlo exact test was applied.

Table 4. Relationship between frequency of consumption and perception of performance

Frequency of consumption	No.	Yes.	Total	P value
Daily	0 (0.0%)	46 (100.0%)	46 (100.0%)	0.1065
Monthly	0 (0.0%)	10 (100.0%)	10 (100.0%)	
Weekly	3 (5.77%)	49 (94.23%)	52 (100.0%)	

Monte Carlo exact test was applied.

port. The nutritional attributes of pseudocereals, including quinoa, chia, and amaranth, are well documented in the literature, particularly for their antioxidant, anti-inflammatory, and anticarcinogenic properties[1]. Quinoa, in particular, has been identified as a crop with potential contributions to food security, partly due to its beneficial effects on digestion and inflammation[22]. At the societal level, university students' food choices are influenced by factors such as cost and convenience, which can sometimes compromise nutritional quality[5]. Cultural and economic contexts also shape dietary habits, contributing to variability in the adoption of health-oriented diets[23]. Even so, positive self-perception of health has been linked to improved behaviors, including higher physical activity levels and better dietary practices[2].

Consumer behavior further reflects a growing interest in health-oriented eating. Olivares reports that there is a rising willingness to pay more for foods with proven nutritional benefits[24]. The literature supports the nutritional value of pseudocereals, highlighting their richness in bioactive compounds and their suitability as components of a balanced diet. Boratyńska and Huseynov found that 99.1% of surveyed consumers recognized a positive relationship between quinoa consumption and health[24], while Franco et al. reported that 52% of consumers in Switzerland and Brazil were willing to change their dietary habits to incorporate Andean foods[25]. Likewise, 100% of surveyed Slovenian youth expressed confidence in the nutritional value of Andean foods, indicating broad cross-cultural acceptance[26].

Scientific literature also supports the health-promoting properties of individual Andean foods. Yábar notes that maca contains phenolic compounds that help counter oxidative damage, glucosinolates and (+)-meyenin A which may reduce cancer risk, and phytosterols that contribute to cardiovascular health—characteristics that reinforce its potential as a functional and nutritionally dense food[27]. Similarly, Campos highlights quinoa's complete protein profile, along with its diverse bioactive components, which are associated with disease prevention and the mitigation of malnutrition. Quinoa leaves also contain proteins and antioxidants, further contributing to its nutritional potential[28].

These findings are consistent with Brozovich-Neyra et al., who reported that perceptions of energy and endurance improvements may vary depending on training intensity and conditioning, which may help explain the non-significant associations found in the present study[29]. Finally, Hernández-Pérez highlights the rich antioxidant profile and essential nutrients present in Andean grains, supporting their potential role in the prevention and management of chronic diseases[30].

CONCLUSIONS

This study explored the frequency of Andean food consumption and its perceived impact on physical performance among university athletes in Lima, Peru. Quinoa emerged as the most frequently consumed Andean food, followed by kiwicha and maca. Most athletes reported consuming these foods on a daily or weekly basis, often as part of mixed meals or in grain form. A high proportion of participants—94.23% of weekly consumers and 100% of daily consumers—reported perceiving positive effects on their physical performance.

However, inferential statistical analysis did not reveal a significant association between frequency of Andean food consumption and self-reported performance perception ($p = 0.1065$). These findings suggest that although athletes may associate these foods with enhanced performance, other determinants—such as overall diet quality, training intensity, and individual health status—are likely more influential in shaping actual athletic outcomes.

Gender-specific patterns were observed: male athletes reported higher consumption of maca, while quinoa intake was similar across genders. By sport, female soccer and volleyball players reported higher quinoa consumption, and male rugby players reported greater maca intake. These trends may reflect both cultural influences and sport-specific dietary practices.

While the results are consistent with existing literature on the nutritional value of Andean foods, they also underscore the complexity of factors influencing performance perceptions. The lack of statistically significant associations highlights the need for further research employing objective performance measures, controlled dietary interventions, and longitudinal study designs.

From a broader perspective, Andean foods such as quinoa, chia, and amaranth represent culturally significant, nutrient-dense options that may contribute to healthier dietary patterns when integrated into balanced eating practices. Their potential as functional foods warrants continued scientific exploration, particularly in the context of sustainable diets and public health. However, barriers such as cost, accessibility, and lack of dietary education may still limit their widespread adoption.

To support the integration of these foods into athletic nutrition, targeted initiatives focused on nutrition education, accessibility, and culturally relevant dietary guidance are recommended. These efforts could contribute to improved health perceptions and dietary quality among athletic populations, while also promoting biodiversity and local food systems.

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