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Nutrition Education Protocol in Artistic Roller Skating: A Quasi-Experimental Pre-Post Study Design

Protocolo de educación nutricional en patinaje artístico sobre ruedas: Diseño de estudio cuasiexperimental pre-post

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ABSTRACT

Introduction: Artistic roller skating is an aesthetic and weight-sensitive sport in which body composition and appearance may influence performance outcomes. Adolescent athletes in these disciplines may be at increased risk of low energy availability, disordered eating behaviors, and sport-specific weight pressures. However, structured nutritional education programs tailored to this population remain scarce. The objective of this study is to describe and propose a structured Nutritional Education Protocol (NEP) for level 11 artistic roller skaters aged 14 or older, and to outline its planned evaluation using a quasi-experimental pre-post design.

Methods: This 24-month protocol includes three phases: baseline assessment (anthropometric measurements and validated questionnaires: KIDMED, EAT-26, and WPS). The second phase consists of six structured educational sessions based on an active pedagogical approach, followed by post-intervention reassessment. Statistical analyses will compare pre-post changes using paired tests and mixed models.

Results: Primary outcomes: Changes in Mediterranean diet adherence (KIDMED score) and eating disorder risk (EAT-26 score) following the intervention. Secondary outcomes: Changes in sport-specific weight pressure (WPS), selected anthropometric parameters, and adherence to the educational sessions. The implementation of the NEP is expected to provide preliminary evidence regarding the feasibility and potential impact of structured nutrition education in artistic roller skating.

Conclusion: This protocol may contribute to the development of preventive nutritional strategies in aesthetic sports and inform future controlled studies.

Keywords: Nutritional status, anthropometry, eating disorders risk, adolescent.

RESUMEN

Introducción: El patinaje artístico sobre ruedas es un deporte estético y sensible al peso corporal, en el que la composición corporal y la apariencia pueden influir en el rendimiento y la puntuación competitiva. Los y las deportistas adolescentes que participan en este tipo de disciplinas pueden presentar mayor riesgo de baja disponibilidad energética, conductas alimentarias de riesgo y presiones específicas relacionadas con el peso corporal. No obstante, existen escasos programas

estructurados de educación nutricional dirigidos específicamente a esta población. El objetivo de este estudio es describir y proponer un Protocolo de Educación Nutricional (NEP) dirigido a patinadores/as de nivel 11 de 14 años o más, así como detallar su futura evaluación mediante un diseño cuasiexperimental pre–post.

Metodología: El protocolo, con una duración prevista de 24 meses, consta de tres fases: evaluación basal (mediciones antropométricas y aplicación de cuestionarios validados: KIDMED, EAT-26 y WPS), implementación de seis sesiones educativas basadas en un enfoque pedagógico activo y participativo, y reevaluación posterior a la intervención. El análisis estadístico comparará los cambios pre–post mediante pruebas para muestras relacionadas y modelos de efectos mixtos.

Resultados: Resultados primarios: Cambios en la adherencia a la dieta mediterránea (puntuación KIDMED) y en el riesgo de trastornos de la conducta alimentaria (puntuación EAT-26). Resultados secundarios: Cambios en la presión relacionada con el peso en el contexto deportivo (WPS), en parámetros antropométricos seleccionados y en los indicadores de adherencia a las sesiones educativas. La implementación del NEP permitirá generar evidencia preliminar sobre la viabilidad y el posible impacto de una intervención estructurada de educación nutricional en el patinaje artístico sobre ruedas.

Conclusión: Este protocolo puede contribuir al desarrollo de estrategias preventivas en deportes estéticos y servir de base para futuros estudios controlados que evalúen su efectividad.

Palabras clave: Estado nutricional, antropometría, riesgo a trastornos de la conducta alimentaria, adolescente.

KEY MESSAGES

- Nutritional education is essential for adolescent artistic roller skaters to promote healthy dietary habits and prevent eating disorders, especially in high-performance contexts.
- A structured intervention protocol (NEP) has been developed and expected for implementation over 24 months, including anthropometric assessments and validated questionnaires (KIDMED, EAT-26, WPS) to evaluate dietary habits and psychological pressures.

- The intervention includes six educational sessions focused on Mediterranean diet principles, hydration strategies, and practical cooking workshops tailored to athletes' training and competition needs.
- Findings are expected to suggest a need for ongoing support and adaptation of nutritional programs for younger athletes and those at lower competitive levels, considering the physiological changes during adolescence and the sport's aesthetic demands.

INTRODUCTION

Artistic roller skating, although not currently included in the Olympic Games, is a well-established sport in Spain, with Catalan athletes achieving notable international recognition. The Catalan Skating Federation comprises approximately 25,000 federative licenses across 12 disciplines, of which nearly 50% correspond to artistic roller skating¹.

In 2021, the Federation implemented a new competition system (RollarCat), restructuring athletes into 11 levels according to age and technical proficiency, with level 11 governed by the International Federation World Skate². Despite its relevance and high participation rates, there is a marked scarcity of scientific literature addressing the nutritional requirements, anthropometric characteristics, and health-related risks associated with this discipline.

Artistic roller skating is classified as an aesthetic and weight-sensitive sport, requiring high levels of power, flexibility, coordination, and technical precision. In such disciplines, physical appearance may influence scoring and competitive outcomes, increasing the pressure to maintain a specific body composition. Previous research has demonstrated that athletes in aesthetic sports are at increased risk of eating disorders compared to other sport categories^{3,4}. The body ideals commonly promoted in female aesthetic disciplines emphasize leanness with low fat mass, whereas male athletes are often expected to combine muscularity with flexibility. Athletes in these disciplines may therefore experience sport-specific pressures related to weight and appearance⁵.

Although figure skating on ice has been more extensively studied, evidence specific to artistic roller skating remains limited. Vila *et al.* (2013)⁶ analyzed the anthropometric and somatotype characteristics of 29 elite roller skaters to determine whether there were significant differences

($p < 0.05$). The study concluded that male skaters ($n=15$) had an endo-mesomorphic somatotype, while female skaters ($n=14$) were mesomorphic followed by endomorphic, the latter being characteristic of younger skaters (girls and adolescents). In both sexes, normal weight was identified according to the Body Mass Index (BMI). Similarly, Pons *et al.* (2015)⁷ analyzed long-term anthropometric data from athletes registered at the High-Performance Center (CAR) of Sant Cugat over more than 20 years across different disciplines. For artistic skating ($n=28$), the results highlighted a predominance of the mesomorphic somatotype among male skaters ($n=11$), with an average age of 19.7 ± 5.6 years. In contrast, among female skaters ($n=17$), the differences between somatotypes were not significant (average age 16.9 ± 3.6 years); in both sexes, the athletes were within the normal weight range (BMIs of 20.9 ± 3.9 and 20.1 ± 2.2 , respectively). However, neither study explored dietary intake, energy availability, or nutritional risk factors. Recent evidence indicates that athletes participating in aesthetic and weight-sensitive sports present a higher prevalence of low energy availability (LEA) and eating disorder risk^{3,4,8} compared with athletes from other sport categories. LEA occurs when energy intake is insufficient to support both exercise expenditure and the physiological functions necessary to maintain optimal health and performance⁸. Prolonged LEA may lead to the development of Relative Energy Deficiency in Sport (RED-S), a multifactorial syndrome affecting metabolic, reproductive, bone, cardiovascular, and psychological health. The International Olympic Committee (IOC) updated its consensus statement on RED-S in 2023, emphasizing the multifactorial health and performance consequences of chronic energy deficiency, as well as the importance of early detection and preventive strategies, particularly in sports where body composition or appearance may influence performance evaluation⁹. Adolescence represents a critical period characterized by rapid somatic growth, hormonal maturation, bone mass accrual, and psychological development^{10,11}. Inadequate energy intake during this stage may compromise reproductive function, bone health, metabolic regulation, and long-term athletic development^{10,11}. Studies conducted in aesthetic disciplines such as figure skating and gymnastics have documented restrictive eating patterns, inadequate caloric intake, and elevated weight-related pressures, often normalized within the sporting environment^{12,13}.

These contextual pressures may increase vulnerability to eating disorders and contribute to the development of RED-S.

From a performance perspective, maintaining an adequate dietary pattern is fundamental for optimizing training adaptations, recovery processes, and competitive outcomes^{14,15}. Evidence-based guidelines emphasize the importance of appropriate macronutrient distribution, nutrient timing (before, during, and after exercise), and individualized hydration strategies to prevent fatigue, injury, and impaired recovery^{14,15}. In adolescent athletes, these nutritional considerations are further compounded by growth-related energy demands¹⁰.

Importantly, systematic reviews have demonstrated that structured, theory-based nutrition education interventions can significantly improve nutrition knowledge, dietary intake, and health-related behaviors in athletic populations¹⁶⁻¹⁸. Nevertheless, few interventions have been specifically designed for aesthetic or weight-sensitive sports, and to our knowledge, no structured nutritional education protocol has been described for artistic roller skating.

Given the combination of aesthetic demands, adolescent vulnerability, and limited sport-specific evidence, the development of a structured Nutritional Education Protocol (NEP) for artistic roller skaters is warranted.

Objectives

The objective of this NEP is threefold: 1) to assess the current dietary habits and anthropometric characteristics of level 11 artistic roller skaters aged 14 years or older; 2) to evaluate their risk of eating disorders and sport-specific weight-related pressures; and 3) to implement and subsequently assess the impact of a structured nutritional education intervention aimed at promoting healthy dietary habits and preventing eating disorders.

Hypotheses

Primary Hypothesis

H1: The implementation of the NEP will result in a statistically significant increase in Mediterranean diet adherence (KIDMED score) from baseline to post-intervention.

Secondary Hypotheses

H2: The NEP will result in a statistically significant reduction in eating disorder risk (EAT-26 score) from baseline to post-intervention.

H3: The NEP will lead to a statistically significant reduction in perceived sport-related weight pressure (WPS score).

H4: Anthropometric parameters (e.g., body fat percentage) will remain stable or improve without evidence of increased low energy availability risk.

H5: Improvements in nutrition knowledge and dietary adherence will be greater among female athletes compared to male athletes (exploratory subgroup hypothesis).

METHODS

Design

The evaluation design of the NEP will be quasi-experimental with a pre-post structure, meaning that changes and processes will be observed within the same individuals. In this type of study, there will be no randomization, and therefore, each individual will serve as their own control.

Participants

The estimated sample size is 60 roller figure skaters competing in the individual free modality. The inclusion criteria will be: a) being at least 14 years old during the calendar year in which the NEP is applied, belonging to the cadet, youth, junior, or senior category; b) being federated at level 11 of the Catalan Skating Federation (the highest level in Catalonia, Spain); c) belonging to the artistic discipline and the “individual free” modality. The exclusion criteria for the NEP will be: a) having an injury at the start of the NEP application; b) having a diagnosed eating disorder; c) having a diagnosed psychiatric disorder; d) following a special diet for health reasons.

Sample Size Calculation

The sample size was calculated for the primary outcome, defined as the change in the Mediterranean Diet Quality Index for Children and Adolescents (KIDMED) score, using a paired t-test approach. Assuming a two-sided α level of 0.05 and 80% power, the required sample size was determined according to the expected standardized effect size (Cohen's d). Using the approximation $n \approx (Z_{\alpha/2} + Z_{\beta})^2 / d^2$, with $Z_{\alpha/2} = 1.96$ and $Z_{\beta} = 0.84$, a total sample of 60 participants would allow detection of a minimum standardized effect size of approximately $d = 0.36$, which can be interpreted as a small-to-moderate effect. To compensate for an expected dropout rate of 15–20%, the target recruitment will be increased to 70–75 athletes.

Recruitment

Participants will be recruited in collaboration with the Catalan Skating Federation and affiliated clubs. Club representatives and coaches will be contacted by email and invited to disseminate information about the study to eligible athletes competing at level 11.

An informational session will be offered to athletes and their families. Written informed consent will be obtained from all participants and, when applicable, from legal guardians for minors. Enrollment will occur consecutively until the target sample size is reached. Reasons for refusal or dropout will be recorded. To enhance retention, reminder communications (email and/or messaging applications) will be sent prior to each session, and flexible scheduling will be offered when feasible. Attendance will be monitored, and participants missing a session will be contacted to facilitate re-engagement. Feedback regarding session satisfaction will be collected to improve adherence and engagement. No financial incentives will be provided; however, participants will receive educational materials and individualized feedback on their assessments.

Study Variables

The primary study variables include changes in Mediterranean diet adherence (total KIDMED score; qualitative, continuous variable, 0-12) and eating disorder risk (EAT-26 score; qualitative, continuous variable, 0-78) from baseline to post-intervention. Secondary variables include changes in perceived weight-related pressure (WPS) (total and subscale scores; qualitative, continuous variable), anthropometric parameters (body mass index, skinfold thickness, muscle mass, estimated body fat percentage, somatotype components; quantitative, continuous variable), and intervention adherence indicators (session attendance, satisfaction survey scores; qualitative). Sex, age, weekly training hours, and years of skating experience will be considered as covariates.

Assessment Instruments

Dietary adherence will be assessed using the Mediterranean Diet Quality Index for Children and Adolescents (KIDMED). Eating disorder risk will be evaluated using the Eating Attitudes Test-26 (EAT-26). Perceived sport-specific weight pressure will be assessed using the WPS scale (WPS-M/WPS-F). Anthropometric measurements will be conducted following International Society for the Advancement of Kinanthropometry (ISAK) standards.

Anthropometric assessment will follow ISAK standards (Level 1 certified evaluator). This includes 21 measurements divided into four different types. Two measurements will be taken for each anthropometric variable, as indicated by the ISAK protocol. If the error percentage exceeds 5% for skinfolds or 2% for other measurements, three measurements will be taken instead of two. As per ISAK guidelines, measurements will be taken on the right side of the body. Only in exceptional cases where this is not possible, the measurement will be taken on the left side and will be duly noted¹⁹.

The KIDMED (Altavilla *et al.* 2019) is a 16-question questionnaire (true/false) that assesses adherence to the Mediterranean diet and is intended for individuals between 2 and 24 years old²⁰. Questions with a negative connotation receive a score of -1, while those with a positive aspect receive a score of +1. The total score is classified into three levels: (1) Optimal Mediterranean diet, >8 points; (2) Improvement needed to align intake with Mediterranean patterns, 4–7 points; (3) Very low diet quality, ≤3 points.

The EAT-26 scale (Garner *et al.* 1982) is a 26-question questionnaire with six possible responses and associated scores (never, rarely, sometimes, often, very often, always) used to assess the risk of eating disorders²¹. If the total score is equal to or greater than 20, it indicates a risk of developing an eating disorder, requiring further investigation.

Finally, the WPS (Reel *et al.* 2013, Gall *et al.* 2014) is a psychometric test designed to capture the pressure perceived by athletes regarding their body weight, shape, size, and appearance^{5,22}. Both WPS-M and WPS-F consist of 14 and 16 questions respectively, with six possible responses (never, rarely, sometimes, often, very often, always), scored from 1 to 6 in a positive direction (always = 6, never = 1). To obtain the total score, the sum is divided by 14 (WPS-M) or 16 (WPS-F); there are also subscales, such as pressure from the coach and/or teammates (or from the sport itself), and appearance pressure, which are calculated separately based on different items.

Procedure

The total duration of the NEP is estimated at 24 months. The research team members will declare no conflicts of interest. The first two months will be dedicated to preparing the protocol and developing the design; during this time, the topic to be addressed will be defined, and the target group will be selected. Initially, the lead researcher will contact the Catalan Skating Federation

to gain a realistic understanding of the relevance of artistic roller skating in Catalonia (Spain), as well as to identify dietary and nutritional needs. Subsequently, the NEP will be evaluated by the Research Ethics Committee of the Universitat Oberta de Catalunya (UOC) to validate its implementation. Hence, all NEP participants will sign an informed consent form after recruitment, as their parents or legal guardians when applicable ([Supplementary Material 1](#)).

The NEP is structured into three phases. The first will be a one-month observational study during which anthropometric data will be collected and three questionnaires will be distributed: KIDMED, EAT-26, and WPS-F or WPS-M. Over the course of one week, a person certified by ISAK Level 1 will conduct the measurements, while a recorder will document the collected data. Each athlete will be scheduled for a specific day and time, and if the athlete is under-18 years of age, an adult will have to accompany them and be present during the measurements. The certified and properly calibrated equipment used will include: a stadiometer, scale, arm span measurer, skinfold caliper, and small diameter caliper. Cultural beliefs and traditions of each participant will be respected by issuing clothing recommendations to ensure the measurements are taken respectfully, quickly, reliably, and efficiently.

The second phase will be the intervention, which will consist of six nutritional education sessions delivered by a dietitian-nutritionist. These sessions will cover various topics related to nutrition and the practice of artistic roller skating: healthy eating for athletes, adapting the diet to sports practice, nutrition before, during, and after physical activity, the importance of maintaining proper hydration, and strategies for eating away from home, including cooking workshops (Table 1). This phase will last six months, with one session per month. A one-week dietary record will be requested at the beginning (session 1), in the middle (session 3), and at the end of this phase (session 6).

All sessions are designed to reinforce the role of appropriate nutrition in optimizing training adaptations, competition performance, and long-term athlete health.

Table 1. Phase 2 – Description of the intervention sessions.

Topic	Description
Sessions	<p>Session 1: How to Maintain a Healthy Diet Session 2: Adapting Your Diet to Sports Practice (Part One) Session 3: Adapting Your Diet to Sports Practice (Part Two) Session 4: My Nutrition on Competition Day Session 5: Hydration for Optimal Sports Performance Session 6: What Should Be in My Lunchbox?</p>
Objectives	<p>Session 1: Improve athletes' knowledge in the field of nutrition to help reduce eating disorder risk. Sessions 2, 3, 4, and 6: Highlight the importance of an optimal healthy diet for athletes, considering their specific needs throughout training and/or competition days. Session 5: Emphasize the importance of proper hydration during both training and competition.</p>
Duration	<p>Sessions 1, 4–6: 2.5 hours each Sessions 2 and 3: 2 hours each All sessions will include a 5-minute break between the lecture and the practical workshop.</p>
Contents Session 1	<ul style="list-style-type: none"> • Understand what the plate method is, and which foods are typical of the Mediterranean diet. • Analyze myths and beliefs about nutrition and dietary habits. • Learn attractive and diverse ways to cook and eat healthily.
Contents Session 2	<ul style="list-style-type: none"> • Adapt dietary intake to daily training load and macronutrient needs. • Analyze myths and beliefs about sports nutrition. • How to create a menu tailored to their specific sports practice.
Contents Session 3	<ul style="list-style-type: none"> • Identify nutritional needs throughout a training day. • Understand how nutritional needs vary depending on the period (before, during, and after training).
Contents Session 4	<ul style="list-style-type: none"> • Plan meal composition for competition days.
Contents Session 5	<ul style="list-style-type: none"> • Understand the importance of hydration and the side effects of dehydration. • Analyze the challenges of staying hydrated throughout the day. • Maintaining proper hydration has a greater beneficial effect on performance than any other nutritional intervention.
Contents Session 6	<ul style="list-style-type: none"> • Apply healthy food selection strategies when eating away from home. • Attractive ways to eat using a lunchbox.
Session Dynamics	<ul style="list-style-type: none"> • Brief introduction of the Nutrition Educator (name, background, etc.) • Presentation of the session objectives • Lecture-style explanation of the content • Group discussion on the content • Break • Cooking workshop • Tasting and discussion of results • Closing

	<ul style="list-style-type: none"> • Satisfaction survey to evaluate the Educator and the activity
Session 1 Development	<ul style="list-style-type: none"> • Explanation of the Mediterranean diet and the foods that comprise it, the plate method, and an overview of different healthy cooking techniques. • An active group discussion will be encouraged around myths and beliefs related to nutrition and dietary habits. • Cooking workshop: Athletes will be divided into four groups, each preparing the same recipe (rice with vegetables and curried chicken) using different cooking techniques (oven, steaming, grilling, and sautéing).
Session 2 Development	<ul style="list-style-type: none"> • Explanation of how to adapt the diet to sports practice using the Food Pyramid for Swiss Athletes (EPSA), including the role of different macronutrients in the body and the recommended consumption frequency of various food groups. • An active group discussion will be encouraged around myths and beliefs related to sports nutrition. • Cooking workshop: Participants will create a menu based on the weekly frequency of different foods, adapted to their current training routine (using the plate method). • A leaflet with the recommendations explained will be distributed.
Session 3 Development	<ul style="list-style-type: none"> • Explanation on how to adapt the diet and what nutrition should look like before, during, and after physical activity. The plate method will also be presented, adjusted according to the athlete's intensity level and training phase. • Cooking workshop: Participants will prepare different pre-training snacks, including: <ul style="list-style-type: none"> ○ Granola with kefir and red berries ○ Oatmeal porridge with banana ○ Carrot sticks with whipped fresh cheese ○ Toast with avocado and egg
Session 4 Development	<ul style="list-style-type: none"> • Review of the learnings from previous sessions • Cooking workshop: Athletes will be divided into four groups to prepare different healthy dishes for the meal before (2 groups) and after the competition (2 groups). The recipes will include: <ul style="list-style-type: none"> ○ Macaroni with vegetables and egg ○ Quinoa salad ○ Baked salmon with potatoes and vegetables ○ Lentils with rice and mushrooms
Session 5 Development	<ul style="list-style-type: none"> • Explanation of hydration and its role in sports performance, strategies to prevent dehydration, how to distribute fluid intake throughout the day based on physical activity, and how to recognize signs of dehydration. • Cooking workshop: Athletes will be divided into four groups to prepare four different types of recovery smoothies: <ul style="list-style-type: none"> ○ Banana smoothie ○ Red berry smoothie ○ Kiwi and peach smoothie ○ Avocado and cocoa smoothie
Session 6 Development	<ul style="list-style-type: none"> • Explanation on how athletes can make healthy food choices when eating away from home (e.g., at restaurants). Guidance will also be provided on food safety, how to store food properly, and how to maintain the plate method when preparing a lunchbox.

- **Lunchbox cooking workshop:** Athletes will be divided into four groups, each preparing a different recipe:
 - Chicken drumsticks with vegetables and quinoa
 - Bell peppers stuffed with couscous and egg
 - Chickpea salad
 - Rice with salmon and vegetable salad

Additionally, a satisfaction questionnaire will be distributed after each nutritional education session ([Supplementary Material 2](#)).

The third phase will be the re-evaluation, during which the anthropometric data collection and the same three questionnaires from the first phase will be repeated. The objective of replicating the first phase will be to identify whether any changes have occurred following the intervention, and if so, what those changes are.

Finally, the last three months of the project will be dedicated to the final analysis of all the data collected, the dissemination of results to all those who have participated in the project, and ultimately, the broader dissemination of the findings. Based on the results obtained from the three questionnaires, especially the EAT-26 and WPS, it will be determined whether further investigation is necessary, such as an interview and assessment by a clinician experienced in eating disorders.

Due to the educational nature of the intervention, blinding of participants and educators is not feasible. However, anthropometric assessments will be conducted by an ISAK-certified evaluator who will not be involved in the educational sessions or statistical analysis. When feasible, the evaluator will be blinded to previous measurement results to minimize measurement bias. Although full blinding is challenging in a longitudinal pre–post design involving the same participants, standardized measurement procedures will be strictly followed to reduce potential bias. Personal data will be processed in accordance with Regulation (EU) 2016/679 of the European Parliament and of the Council (General Data Protection Regulation, GDPR) and Organic Law 3/2018 of December 5, on the Protection of Personal Data and Guarantee of Digital Rights. The study will comply with the principles established in the Convention on Human Rights and Biomedicine (Oviedo Convention), ratified by Spain, as well as with the ethical principles of the Declaration of Helsinki of the World Medical Association.

Pedagogical Framework

The NEP is grounded in a constructivist and learner-centered pedagogical approach, promoting active participation and experiential learning. The intervention integrates principles of health education and behavior change theory, emphasizing knowledge acquisition, critical thinking, self-efficacy, and practical skill development. Educational strategies are designed to move beyond passive information delivery and instead foster reflective learning, problem-solving, and decision-making skills relevant to real-life sport contexts.

The sessions incorporate interactive components such as group discussions, case-based scenarios, practical workshops, and applied meal-planning exercises tailored to training and competition demands. This approach is consistent with international recommendations for effective nutrition education in athletes and aligns with established sport nutrition guidelines from organizations such as the IOC and the American College of Sports Medicine (ACSM).

The intervention also draws on behavior change principles, including goal setting, self-monitoring (via dietary records), feedback, and reinforcement strategies to enhance adherence and long-term habit formation.

Data Analysis

Data collection will be carried out in an anonymized manner using Microsoft Excel® spreadsheets. The subsequent statistical analysis will be performed with the Statistical Package for the Social Sciences (SPSS®) for Windows. Descriptive statistics will be used to summarize participant characteristics and study variables. Continuous variables will be reported as mean \pm standard deviation (SD) or median (interquartile range), depending on data distribution, while categorical variables will be presented as frequencies and percentages. Normality will be assessed using the Shapiro–Wilk test together with graphical inspection.

Changes between pre- and post-intervention measurements will be evaluated using paired Student's t-tests for normally distributed variables or the Wilcoxon signed-rank test when normality assumptions are not satisfied. Effect sizes will be estimated using Cohen's d for paired samples and interpreted according to conventional thresholds (small ≥ 0.2 , medium ≥ 0.5 , large ≥ 0.8), with corresponding 95% confidence intervals. To account for the repeated-measures structure of the data and potential confounding factors, linear mixed-effects models will be fitted

including time (pre/post) as a fixed effect and participant as a random effect. Sex, age group, weekly training hours, and years of skating experience will be considered as covariates where appropriate. This modelling approach allows the inclusion of participants with incomplete follow-up data under the missing-at-random assumption. Categorical outcomes will be analyzed using McNemar's test or generalized linear mixed models as appropriate. Statistical significance will be set at $p < 0.05$, and when multiple comparisons are conducted, false discovery rate adjustment will be applied using the Benjamini–Hochberg procedure. Exploratory subgroup analyses will be performed by sex and age category (cadet, youth, junior, senior) when sample size permits, and interaction terms (time \times sex and time \times age group) will be included in mixed-effects models to explore potential differential effects of the intervention.

Missing Data Management

The extent and pattern of missing data will be documented. If missing data are $\leq 5\%$, complete-case analyses will be performed alongside intention-to-treat (ITT) analyses. If missing data exceed 5%, multiple imputation using chained equations (minimum 20 imputations) will be applied under the MAR assumption. Sensitivity analyses comparing imputed and non-imputed datasets will be conducted to evaluate robustness.

RESULTS

As this manuscript presents a study protocol, no empirical results are currently available. The implementation of the NEP is expected to provide a comprehensive overview of the dietary habits, anthropometric characteristics, and eating disorder risk profile of level 11 artistic roller skaters aged 14 years or older.

It is anticipated that the baseline assessment will allow identification of potential areas for improvement in dietary adherence, nutritional knowledge, and awareness of low energy availability risk. The post-intervention evaluation will enable the analysis of changes in Mediterranean diet adherence, eating disorder risk indicators, sport-specific weight pressures, and selected anthropometric parameters.

Although improvements in dietary behaviors and risk awareness are hypothesized, the magnitude and direction of these changes cannot be determined in advance. The findings will

contribute to generating preliminary evidence regarding the feasibility and potential effectiveness of a structured nutritional education intervention in this specific sport population. The results derived from this protocol may inform future controlled studies aimed at strengthening causal inference in aesthetic sports contexts.

DISCUSSION

The present NEP is designed to establish a reference framework for body composition and dietary habits in artistic roller skating athletes in our region. Having sport-specific anthropometric reference values may facilitate the development of individualized nutritional strategies and training programs adapted to the physiological demands of this discipline^{6,7}. Although previous studies have described somatotype and anthropometric characteristics in roller skaters, nutritional intake and energy availability have not been comprehensively investigated in this population.

The protocol is intended for athletes aged 14 years and older, a stage at which adolescents progressively gain autonomy in their dietary choices. Nutritional education during this developmental period may be particularly relevant, as adolescence represents a critical phase of rapid growth, hormonal maturation, and bone mass accrual^{10,11}. Inadequate energy intake during this stage has been associated with potential adverse consequences for reproductive function, bone health, and metabolic regulation¹¹. Therefore, implementing preventive strategies at this age could contribute not only to performance optimization but also to the promotion of long-term health and the reduction of eating disorder risk.

The design of this NEP is aligned with current international recommendations regarding the prevention of LEA and RED-S in weight-sensitive disciplines⁹. According to the 2023 IOC consensus statement, sports in which body composition or aesthetic appearance influence performance evaluation represent high-risk contexts for the development of RED-S and eating disorders^{8,9}. Artistic roller skating shares key characteristics with other aesthetic sports such as figure skating and gymnastics, including subjective scoring systems and emphasis on body shape, factors that may increase weight-related pressures within the sporting environment^{5,12,13}.

Evidence from aesthetic disciplines, particularly in figure skating, has documented restrictive dietary patterns and hypocaloric intake among adolescent athletes¹². Sport-specific pressures related to weight and appearance^{5,13} may further increase vulnerability to LEA and to conditions within the female athlete triad spectrum¹¹.

Athletes presenting eating disorder symptomatology constitute a specific population with distinct clinical and educational needs, requiring targeted preventive strategies within the sporting context²³. Recent evidence has also shown associations between low energy availability, eating disorder risk, and psychological variables such as pre-competitive anxiety in high-performance female athletes²⁴.

From a performance perspective, maintaining an adequate dietary pattern is considered fundamental for optimizing training adaptations, recovery, and competitive outcomes^{14,15}. Evidence-based guidelines emphasize appropriate macronutrient distribution, nutrient timing strategies, and adequate hydration to reduce fatigue, injury risk, and impaired recovery^{14,15}. In adolescent athletes, these nutritional considerations are further compounded by growth-related energy demands¹⁰.

Systematic reviews suggest that structured, theory-based nutrition education interventions may improve nutrition knowledge and dietary intake in athletic populations¹⁶⁻¹⁸. However, few interventions have been tailored to aesthetic or weight-sensitive sports, and none have been specifically described in artistic roller skating. If successfully implemented, this protocol could contribute to addressing this gap in the literature by integrating anthropometric assessment, validated screening tools (EAT-26 and WPS), and evidence-based educational strategies aligned with IOC recommendations.

In Spanish female athletes participating in aesthetic sports, including artistic roller skaters, Teixidor-Batlle *et al.* (2019)¹³ identified body-related pressures and sport-specific weight monitoring practices as significant risk factors for eating disorders. These findings reinforce the relevance of implementing preventive educational strategies in disciplines where aesthetic demands and external evaluation may normalize restrictive behaviors.

Strengths of the Proposal

This protocol presents several strengths. First, it integrates anthropometric assessment, validated psychometric instruments, and a structured educational intervention within a single comprehensive framework. Second, it is grounded in current international consensus statements on RED-S and evidence-based sport nutrition guidelines. Third, it specifically targets adolescent athletes in a weight-sensitive discipline, a population considered vulnerable to low energy availability and disordered eating behaviors.

Additionally, the intervention incorporates an active, learner-centered pedagogical approach, which may enhance engagement and long-term behavioral change.

Limitations

This study follows a quasi-experimental pre–post design without a control group, which introduces inherent limitations in internal validity. Several potential sources of bias must be acknowledged.

First, history effects may occur if external events (e.g., competition schedule changes, coaching modifications, or concurrent nutrition advice) influence participants' behaviors during the intervention period independently of the NEP. Second, maturation effects are particularly relevant given the adolescent age range of participants. Natural developmental changes in growth, hormonal maturation, and body composition may influence dietary habits or anthropometric outcomes over time, independently of the intervention. Third, testing effects may arise from repeated administration of questionnaires (KIDMED, EAT-26, WPS), as participants may become more familiar with the instruments or more aware of socially desirable responses at post-intervention. Additionally, regression to the mean may partially explain changes observed among participants with extreme baseline values, and selection bias may be present due to voluntary participation.

Attrition also represents a potential limitation. Participants may withdraw due to injuries, academic or professional commitments, motivational factors, sports pressure, or lack of family support. Furthermore, the extended study duration increases the likelihood of developmental changes that may independently affect outcomes.

To mitigate these risks, anthropometric assessments will follow standardized ISAK procedures conducted by certified evaluators, data collection conditions will be consistent, and statistical analyses will adjust for age and training exposure. Nevertheless, causal inference will be interpreted cautiously, as the absence of a parallel control group prevents disentangling intervention effects from secular trends. Future research should consider controlled or cluster-randomized designs to strengthen causal inference and external validity.

Periodical follow-up assessments after completion of the NEP may also help evaluate the sustainability of potential behavioral changes.

Additionally, although exploratory subgroup analyses by sex and age category are planned, the study may not be sufficiently powered to detect small differences between subgroups. Therefore, these analyses will be considered exploratory and interpreted with caution.

Practical Applications

If implemented successfully, this NEP may provide a structured and reproducible framework for improving nutritional knowledge, dietary habits, and awareness of low energy availability risk among artistic roller skaters. The protocol may serve as a reference model for sport federations, coaches, and sports nutrition professionals working in aesthetic and weight-sensitive disciplines. Furthermore, the integration of validated screening tools (KIDMED, EAT-26, WPS) alongside anthropometric assessment may facilitate early detection of nutritional risk patterns and weight-related pressures, supporting preventive strategies within youth sport settings.

Future Research Directions

Future studies may expand this protocol to include randomized controlled designs with comparison groups to strengthen causal inference. Long-term follow-up assessments could evaluate the sustainability of behavioral changes and potential effects on performance outcomes.

Future adaptations of the NEP may allow its extension to lower competitive levels (levels 8-10) and potentially to younger athletes, incorporating additional emphasis on nutritional periodization and long-term athlete development. Also, this framework could be adapted to other artistic roller skating disciplines, such as show groups, solo dance, dance pairs, or artistic pairs, where similar aesthetic and performance demands are present; also to other aesthetic

disciplines such as dance or gymnastics. Future research may also explore the inclusion of psychological support components or digital tools to enhance adherence and monitoring.

CONCLUSIONS

Given the current lack of available evidence, the importance of this project and the NEP will lie in the number of athletes practicing artistic roller skating in Catalonia (Spain) and the interest shown by some of them, especially those at a high-performance level, in nutrition and how it can influence their performance. The intervention has been designed for skaters aged 14 and older at level 11, which is strictly governed by international regulations, and includes athletes who may later qualify for national and international championships.

AUTHORS' CONTRIBUTIONS

All authors contributed to the writing and editing of the study protocol.

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The authors declare that no funding was received for the conduct of this study.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding writing this manuscript.

DATA AVAILABILITY

Data will be made available upon reasonable request to the corresponding author. However, this manuscript presents a research protocol that has not yet been implemented.

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