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Inequalities in Adolescent Physical Activity in Catalonia: The Influence of Socioeconomic Status, Immigration, and Gender

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Abstract

Physical activity (PA) during adolescence is essential to physical, mental, and social development. However, not all teens have equal access to these benefits. Cultural and socioeconomic status (SES), immigrant background, and gender are all factors that condition how often adolescents engage in PA. In Catalonia, these inequalities are particularly relevant given the growing diversity and the ongoing socioeconomic inequality in the region. Using data from the PISA 2022 study of 1,524 15-year-old Catalan adolescents, we analyzed the impact of inequality factors on weekly participation in PA. The results show significant differences in weekly AF frequency according to adolescents' NSEC ($p < .001$). While high NSEC is predominantly associated with intermediate frequencies (2–4 times/week), low NSEC is overrepresented in both the low-practice category (0–1 time/week) and the very high-practice category (≥ 5 times/week).Regarding immigrant background, native adolescents reported participating more often in PA than first-generation immigrants, particularly in higher frequencies (≥ 3 times/week). As for gender, boys clearly outnumber girls regarding frequency of participation in PA, with 58.35% engaging in PA 5 or more times per week compared to 33.37% of girls. These inequalities bring to light the social, economic, and cultural barriers that limit vulnerable groups' access to PA. We underscore the need to create policies that promote women's and girls' participation in PA, specific subsidies, and cultural integration programs, to foster equitable access and ensure the benefits of PA on adolescents' well-being.

Keywords: adolescents, gender, immigration, inequality, physical activity, socioeconomic status

Introduction

Physical activity (PA) and sport are essential for the healthy development of individuals, as they help prevent disease and improve mental health, quality of life, and social skills, thereby enhancing overall well-being (Dimitri et al., 2020; Poitras et al., 2016). With this in mind, institutions and governments have promoted strategies to encourage PA as a tool to foster well-being and quality of life (WHO, 2020). However, these benefits may be curtailed during adolescence due to various invisible barriers that must be eliminated. Various studies have discussed inequalities in participation in PA among adolescents due to social and cultural factors (Alliott et al., 2022).

The current literature describes three fundamental factors of inequality that condition frequency of participation in PA: cultural and socioeconomic status (SES), immigrant background, and gender, (Ferry & Lund, 2016; Kaya et al., 2021; Tandon et al., 2021). As far as socioeconomic status is concerned, youth with higher SES engage in PA more often, which can be explained by their greater economic capacity to access sports activities and suitable facilities (Eime et al., 2017; Tandon et al., 2021). In terms of immigrant background, barriers to social and cultural integration often hinder access to organized sports and PA among adolescents from immigrant families. Meanwhile, a lack of sports role models or inclusive cultural spaces can also aggravate this exclusion (Kaya et al., 2021). In that sense, adolescents from immigrant backgrounds may experience a lack of cultural and social support (Alliott et al., 2022; Eime et al., 2017).

Lastly, gender is another decisive factor, as girls tend to participate less in PA (Ferry & Lund, 2016; Gutiérrez & García-López, 2012; Muñoz-Arroyave et al., 2021). According to the literature, this difference in participation level may be due to social stereotypes, expectations, or perceptions of ability, which ultimately influence adolescent girls' decisions to participate, or not, in physical activities (Moreno-Vitoria et al., 2024; Vidal-Conti, 2016). Internationally, there is growing concern around gender-related inequality, as seen in instruments like the International Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) and the revised UNESCO International Charter of Physical Education, Physical Activity, and Sport (Flores et al., 2022), which promote gender equality in sports.

Socioeconomic and cultural inequalities cause a social divide that is also observed in adolescents' participation in PA, with the consequent negative impact on their physical and social well-being. While policies targeted at fixing this situation are established by designating funds, publishing formal guidelines, and establishing sports agendas, the individuals responsible for formulating this response rarely come into direct contact with the end users. This aggravates the divide between the creation of inclusive policies and their actual execution, thus reducing the impact and actual access for these groups (Dashper et al., 2019). Some countries have implemented strategies to guarantee equitable access to sports activities, such as creating specific subsidies and cultural support programs for less affluent groups (Hämäläinen et al., 2016), a type of initiative that is essential to promoting PA in adolescents from different backgrounds and socioeconomic situations, thereby contributing to a more inclusive society.

The most recent studies conducted in Catalonia identified the following three main factors of inequality regarding participation in extracurricular sports: background of the children and adolescents—up to a 25% difference between native-born and immigrant-origin children (Alegre & Morató, 2025), socioeconomic status of the families—up to 24% difference between more affluent and more vulnerable families (Mencía & Samper, 2023), and gender (Observatori Català de l'Esport, 2023). Nevertheless, the available data for Catalonia are limited, particularly regarding children and adolescents. Except for the survey on extracurricular participation in Catalonia (Mencía & Samper, 2023), no specific studies have analyzed the participation in and frequency of PA among children and adolescents, nor the impact of factors such as gender, immigrant background, and socioeconomic status on said participation. It is also crucial to take an in-depth look at how these factors interact and amplify inequality in the frequency of adolescents' engagement in PA.

Therefore, the objective of this research was to analyze the frequency of Catalan adolescents' participation in PA based on SES, immigrant background, and gender. The study aimed to gain a better understanding of how different factors of inequality influence participation in PA. The resulting information could be key to advancing the creation of policies and interventions targeted at promoting equitable PA participation in adolescents.

Methodology

Participants

The study was conducted using data from the PISA 2022 database (OECD, 2023), analyzing a sample of 1,524 high school students (15 years old, 10th grade) in Catalonia. We chose this age group as it was the sample used in the PISA study, which measures the skills and knowledge of 15-year-old students around the world. PISA uses a stratified sample design, which randomly selects schools that represent a series of students from every region or country.

This study was conducted in accordance with the European Code of Conduct for Research Integrity (ALLEA, 2023) to uphold ethical research practices, and complied with the PISA ethical guidelines, which guarantee the privacy of the participants and institutional confidentiality. In Spain, participation in the PISA program is regulated by Organic Law 2/2006 (LOE) and its subsequent modifications modifications, including the laws LOMCE the laws LOMCE and LOMLOE (by their Spanish acronyms), which regulate participation in educational assessments by schools and students. Data protection standards are also guaranteed by the Spanish government.

Materials and Instruments

We collected data from the PISA 2022 database, an international standardized program that assesses 15-year-olds' reading, mathematics, and science abilities. The questionnaire included sections that collected information about socioeconomic status, family, lifestyle habits, and PA.

The independent variable was the frequency of weekly PA, as reported in PISA through a questionnaire that asked participants how many days per week they engaged in physical exercise outside school hours. We established six categories ranging from no days of PA practice to 1, 2, 3, 4 and 5 or more times per week.

To facilitate the analysis and interpretation of the results, we placed the male and female participants who engaged in PA 5 or more times per week into a single group, as this threshold allowed us to identify adolescents who regularly and frequently participated in PA.

The independent study variables were socioeconomic status, immigrant background, and gender. In terms of cultural and socioeconomic status, we used the scale that PISA builds for each student based on the employment information of their parents, the education level, and home resources. Participants were classified into three groups (low, medium, and high) using the 25%, 50% and 75% percentiles. In terms of immigrant background, the OECD classifies this according to three groups:

1. *Native*: adolescents whose parents were born in the same country.
2. *Second-generation*: adolescents born in the country of assessment but with at least one parent born in another country.
3. *First-generation*: adolescents born outside the country of assessment or whose parents were born abroad.

Lastly, in terms of gender, the OECD limits categorization to the dichotomous variable of male or female.

Data Analysis

We calculated the descriptive statistics for each independent and dependent variable. We then used the chi-square test to assess the relationship between each independent variable (cultural and socioeconomic status, immigrant background, and gender) and the frequency of weekly exercise. This allowed us to identify whether the differences observed between groups were statistically significant. To identify where there were significant differences, we conducted post hoc tests via the analysis of adjusted standardized residuals. This approach allowed us to determine which combinations of gender, socioeconomic status, and immigrant background presented more prominent inequalities in participation in PA. To supplement the analysis, we included multinomial logistic regression models to explore the interaction between gender, socioeconomic status, and immigrant background regarding participation in PA. This intersectional approach allowed us to identify specific patterns of inequality resulting from a combination of these factors.

We used the program SPSS version 29.0 to conduct the statistical analyses. The significance level was set at $p < .05$. Significant associations were interpreted as indicators of unequal participation in PA according to the three analyzed factors.

Results

The study included 1,524 10th-grade adolescents with an average age of 15 years according to the OECD (758 girls and 766 boys) who participated in the PISA 2022 study. That said, the sample size varied according to the variables analyzed: 1,132 adolescents in the socioeconomic status-based analysis and 1,443 in the immigrant background-based analysis. This variation is due to the use of personalized questionnaires by PISA and because not all participants responded to all questions. Despite this reduction the analyses guarantee a representative sample in all the areas analyzed.

Table 1
Social, cultural, and economic status index percentiles used in this research

Cultural and socioeconomic status percentile	Cut-off percent	Cut-off value
Low	25	–.567200
Medium	50	.182900
High	75	.792800

Table 2
Frequency of weekly sport or exercise before or after school according to socioeconomic status

Socioeconomic status	Does not engage in exercise or sport	1 time per week	2 times per week	3 times per week	4 times per week	5 times or more per week	TOTAL
Low	66 (17.74%)	18 (4.83%)	41 (11.02%)	26 (6.98%)	38 (10.21%)	183 (49.19%)	372
Medium	60 (15.78%)	12 (3.15%)	48 (12.63%)	47 (12.36%)	47 (12.36%)	166 (43.68%)	380
High	40 (10.52%)	10 (2.63%)	49 (12.89%)	58 (15.26%)	56 (14.73%)	167 (43.94%)	380
TOTAL	166 (14.66%)	40 (3.53%)	138 (12.19%)	131 (11.57%)	141 (12.45%)	516 (45.58%)	1132

Socioeconomic and Cultural Status and Fequency of Engagement in Exercise or Sport

The socioeconomic status variable was categorized into three groups (low, medium, and high) based on the social, cultural, and economic status index percentiles (see Table 1). The results showed a differing distribution in the frequency of participation in PA based on socioeconomic status (see Table 2).

Regarding high-frequency exercise, 73.93% of adolescents with high socioeconomic status engaged in physical activity 3 or more times per week, representing the group with the highest participation in this range. In contrast, at lower frequencies (never or once per week), a higher percentage of adolescents with low socioeconomic status was observed (22.57%) compared to the others (18.93% medium and 13.15% high). Additionally, at 5 or more times per week, the group with the highest participation was the low socioeconomic status group (49.19%), nearly 6% higher than the medium- and high-status groups. In that sense, the chi-square test revealed significant associations between the cultural and socioeconomic status variable and the frequency of weekly participation in sports or exercise ($\chi^2(20) = 50.720$; $p < .001$). Standardized residuals revealed that groups with a lower percentile of socioeconomic status were concentrated in the 0 and 1 times per week exercise categories (residuals of 2.0 and 1.7, respectively), as well as in the 5 or more times per week category (residual of 1.7). In contrast, groups with a higher percentile were concentrated in the 3 and 4 times per week categories (residuals of 2.8 and 1.7).

Immigrant Background and Frequency of Exercise or Sport

With regard to familial immigrant background, the adolescents were grouped into three categories according to the OECD classification: natives, second-generation, and first-generation. A higher proportion of native participants reported exercising regularly, with 14.10% engaging in PA 4 times per week, compared to 9.75% of second-generation and 8% of first-generation adolescents. The proportion of adolescents who did not participate in any type of exercise was notably higher among first-generation participants (23.20%) compared to the native adolescents (11.41%). At a frequency of 3 times per week or more, native adolescents were the most active in sports or exercise, while at frequencies between 0 and 2 days per week, first-generation adolescents were the most represented. Table 3 shows the detailed results.

When the distribution of PA frequency was analyzed by immigrant background based on the chi-square test, a significant association became apparent ($\chi^2(20) = 42.087$, $p = .003$). The adjusted standardized residuals revealed that first-generation immigrant background adolescents had a higher presence in the 0 and 1 times per week categories (residuals of 3.5 and 1.8, respectively), while native adolescents presented significant positive associations in the 3 to 5 times per week categories (residuals of 2.2, 2.4, and 1.7).

Table 3
Weekly frequency of participation in exercise or sport according to immigrant background

Immigrant background	Does not engage in exercise or sport	1 time per week	2 times per week	3 times per week	4 times per week	5 times or more per week
Native	127 (11.41%)	31 (2.78%)	140 (12.57%)	156 (14.01%)	157 (14.10%)	502 (45%)
Second-generation	33 (16.09%)	12 (5.85%)	24 (11.7%)	17 (8.29%)	20 (9.75%)	99 (48%)
First-generation	29 (23.2%)	8 (6.4%)	15 (12%)	14 (11.2%)	10 (8%)	49 (39%)
TOTAL	189 (13.09%)	51 (3.53%)	179 (12.4%)	187 (12.95%)	187 (12.95%)	650 (45%)

Table 4
Weekly frequency of exercise or sport by gender

Gender	Does not engage in exercise or sport	1 time per week	2 times per week	3 times per week	4 times per week	5 times or more per week
Female	133 (17.54%)	39 (5.14%)	118 (15.56%)	110 (14.51%)	105 (13.85%)	253 (33.37%)
Male	65 (8.48%)	14 (1.82%)	68 (8.8%)	80 (10.44%)	92 (12.01%)	447 (58.35%)
TOTAL	198 (12.99%)	53 (3.47%)	186 (12.2%)	190 (12.46%)	197 (12.92%)	700 (45.93%)

Gender and Frequency of Exercise or Sport

Male adolescents presented more frequent participation in physical exercise compared to the female population. Some 58.35% of the boys reported engaging in some form of exercise 5 times or more per week, while only 33.37% of the girls reported this level of frequency. By contrast, the girls presented a higher proportion of participants who did not participate in any exercise or sport (17.54% for girls compared to 8.48% for boys). For the 5 times per week or more frequency, we observed higher participation among boys while girls' participation in exercise or sport was higher in the frequency of up to 4 days per week.

The chi-square test revealed significant associations between the gender variable and the frequency of weekly participation in sport or exercise ($\chi^2(10) = 126.148$; $p < .001$). The adjusted standardized residuals showed that girls had a higher presence in the 0, 1, and 2 days per week categories (residuals of 5.3, 3.5, and 4.0, respectively) while boys had a higher presence in the 5 days or more per week category (residuals of 4.0 and 7.5).

Our multinomial logistic regression analysis of the interaction between the gender, cultural and socioeconomic status, and immigrant background variables identified significant effects, particularly among the lower participation frequencies. The results show that, for the 0 days of PA per week category, the interactions between female gender and socioeconomic status percentiles 1 and 2 were significant ($p < .001$), indicating that girls with a lower socioeconomic status were less likely to participate in sports or exercise. By contrast, this interaction was not significant for socioeconomic status percentile 3 ($p = .393$), suggesting that the highest socioeconomic status does not have the same impact on girls' participation in exercise activities.

In the case of engaging in PA 1 day per week, we did not observe any significant interaction between gender and socioeconomic status. Nevertheless, in the 2 days of PA per week category, this was significant for socioeconomic status percentiles 1 and 2 ($p < .001$), but not significant for percentile 3 ($p = .717$). In terms of immigrant background, the results did not present significant effects in the interaction with other variables.

Discussion

The study results show that socioeconomic status, immigrant background, and gender are factors that contribute to unequal participation in PA in adolescents in Catalonia. Adolescents with higher socioeconomic status and those considered native exhibit higher AF frequency in the range of 2 to 4 times per week. According to recent studies in Catalonia, this is the weekly practice range most associated with positive effects on academic performance (Roig-Hierro et al., 2025). Unexpectedly, adolescents with lower socioeconomic status show higher participation in the 5 or more times per week range. Although this may seem like a positive outcome, such very high frequency has also been linked to potential distracting effects and negative impacts on academic performance (Roig-Hierro et al., 2025). In terms of gender, girls presented lower participation in PA than boys. In addition, the results point to a significant intersection between socioeconomic status and gender that amplifies the observed inequalities. Specifically, girls from low socioeconomic status families presented notably lower participation in PA compared to both boys with the same socioeconomic status and adolescents with a higher socioeconomic status. These results allow us to highlight these three factors—socioeconomic status, immigrant background, and gender—as key elements of inequality in adolescents' weekly participation in PA.

Previous studies have pointed to socioeconomic status and immigrant background as key factors that condition access to PA (Kaya et al., 2021; Tandon et al., 2021; Alegre & Morató, 2025; Mencía & Samper, 2023). In that regard, the study on extracurricular participation in Catalonia promoted by the organization *Educació 360* emphasized that inequality in extracurricular sport activities not only manifests in participation rate, but also in the type of activity and intensity of practice (weekly hours) (Mencía & Samper, 2023). This evidence highlights the importance of broadening our analysis beyond mere participation in PA to examine its frequency and type as key aspects to gaining a better understanding of inequality in this setting. The results of this study align with previous literature, which indicates that adolescents with higher socioeconomic status have greater access to sports activities and quality facilities, due to their families' purchasing power (Ramos et al., 2016). However, further interpretation is needed regarding the finding that adolescents from lower socioeconomic backgrounds concentrate a higher proportion of physical activity practice (≥ 5 times/week). While this may reflect high levels of physical engagement, it could also mask underlying inequalities, as these high frequencies have been associated with factors such as low educational attainment, low self-esteem, or eating behavior disorders (Caponetto et al., 2021). This paradox provides a relevant avenue for further analysis to better understand the links between intense physical activity practice and social vulnerability.

These inequalities have a long history, with data from the Observatori Català de l'Esport (2014) showing that, in terms of socioeconomic status, some 17.9% of the upper-middle/upper class plays one sport and 46.2% plays multiple sports, while only 10.3% does not play any sport. On the other hand, among unqualified blue-collar workers, 18.4% practice one sport, 14.3% multiple sports, and 32.7% no sports at all.

Beyond socioeconomic status, students from an immigrant background, particularly first-generation adolescents, participate in PA less frequently than their native counterparts. This result is in keeping with studies that have identified issues with social and cultural integration as another barrier in addition to economic limitations (Kaya et al., 2021). In Catalonia, where diversity has grown significantly due to immigration (Ruiz-Trasserra et al., 2017), guaranteeing inclusion in sport and PA for all groups is fundamental. This evidence highlights the need for specific support, such as social guidance measures and inclusion strategies to prevent youth from developing sedentary habits and suffering from the subsequent negative repercussions on their long-term health and well-being (van Sluijs et al., 2021).

This study's results also confirm the existence of gender inequality in PA participation, revealing that girls tend to participate in PA less often than boys. These gender differences in PA have been discussed in multiple studies (Ferry & Lund, 2016; Gutiérrez & García-López, 2012; Muñoz-Arroyave et al., 2021) that attribute this inequality to gender stereotypes, concerns about performance and social acceptance, and girls' perceptions of sport as a non-inclusive space (Ramos et al., 2016; Vidal-Conti, 2016).

As highlighted in the present study, it is possible that gender inequality also intersects with other factors of inequality, such as socioeconomic status. This interaction suggests that the combination of social disadvantages may have a cumulative effect that additionally limits access to PA. This underscores the need to create inclusive policies that jointly address such inequalities and respond to the specific needs of the most vulnerable population groups (Hämäläinen et al., 2016).

To promote greater equity in participation in PA, inclusive policies are essential and must go beyond accounting for the supply and consider more broadly the plethora of barriers facing these groups (Dashper et al., 2019). Facilitating factors could include subsidies to lower registration costs for sports activities targeted at less affluent families, and specific programs aimed at immigrant youth that foster a safe and inclusive environment for engaging in PA (Ajuntament de Barcelona, 2023). Likewise, a cultural shift must be encouraged in school sports by adopting strategies to break down gender stereotypes and offering a diverse range of activities that will draw the attention of both boys and girls. Adopting these measures could contribute to reducing inequalities in PA and allow all adolescents to access the physical and psychological benefits of sports activity.

These facilitating factors must be implemented within a broader commitment from the public administration. The study results reveal a structural problem that cannot be tackled solely with isolated measures or one-off interventions. A global strategy is needed that incorporates these elements within an educational policy for extracurricular sports featuring concrete mechanisms to guarantee equitable access to PA, specifically for vulnerable groups.

As reported by Alegre & Morató (2025), despite the existence of extracurricular programs targeted at these specific groups in multiple towns, their implementation is heterogeneous and largely depends on the availability of local resources. This demonstrates the need to integrate these initiatives within a stable and coordinated political framework that considers PA to be a key element of the educational agenda. The objective must involve guaranteeing a quality, accessible, and diverse offering of sports activities, thereby fostering truly equitable access to the physical, social, and psychological benefits of PA and sports.

Multiple initiatives can serve as an example for future policies. In Barcelona, the subsidy program for extracurricular sports activities for less affluent families is committed to improving access to PA (Ajuntament de Barcelona, 2023). Cultural projects like the *Criquet Jove a BCN* [Youth cricket in Barcelona] promote the integration of immigrant youth within a sporting context that caters to their cultural interests, creating safe spaces to participate in PA and contributing to social cohesion (CEAi & FEEB, 2024). Other programs such as the *Escola Esport Ciutat* [School Sport City] (Ajuntament de Barcelona, 2024) promote unconventional sports in schools, offer opportunities to broaden the variety of activities available to students, facilitate the discovery of new sports, and foster active lifestyles from a young age and connection during after-school hours. One additional option could be to incorporate specific mechanisms to identify and include vulnerable groups using individual criteria in addition to regional criteria, as part of currently active programs in Catalonia like *Fitjove* (Generalitat de Catalunya, 2023).

Limitations and Future Directions

This study has various limitations that must be taken into account when interpreting the results. First, because the data was sourced from the PISA report, our sample only includes 15-year-old adolescents, which could hinder extrapolation to other adolescent age groups. Future research is needed of a longitudinal nature or focused on other age groups to analyze the evolution of participation in PA over time. Additionally, this study should be supplemented by a more qualitative analytical perspective that can offer an in-depth understanding of the perceived motivations and barriers among adolescents in vulnerable situations. Second, this study focused on a specific geographical context, namely Catalonia, and a limited set of variables, which could limit generalization of the results to other regions or sociocultural settings. Broadening the research to other contexts and variables could offer a more complete vision of inequalities in PA.

Additionally, the analysis did not delve into the type of PA performed, a key aspect for better understanding the observed differences. The influence of factors such as financial resources or cultural dynamics also deserves more detailed investigation, particularly via qualitative methodologies. Lastly, the frequency of PA was measured using a single question in the PISA questionnaire, which could have introduced self-perception bias. We recommend that future research use validated instruments like the PAQ-C (Bello et al., 2020) to obtain more precise and reliable measures.

As a call to action, we propose that public institutions bolster implementation of inclusive policies that guarantee equitable access to PA for all adolescents with a specific focus on more vulnerable populations. In addition to these measures, developing a comprehensive education policy based on the *Educació 360* model could be key to promoting participation in extracurricular sports activities among at-risk children and youth. This requires a structural approach that involves modifying visibility of and access to PA opportunities as educational spaces for the fundamental development of adolescents. This involves making a firm, systematic, and sustainable commitment to universal access to and participation in PA. To achieve this objective, solid inter-institutional support will be required, as well as coordinated participation from the educational and community ecosystem around the adolescent population. Cross-sector policies must be designed in coordination with all the implicated departments (sports, education, youth, social and feminist rights) and coordinated actions must be taken by local administrations, educational centers, sports organizations, and families to work towards greater equity in participation in PA and the promotion of healthy and active lifestyles among Catalan youth.

Conclusions

Catalonia presents significant inequalities in adolescents' participation in PA according to socioeconomic status, immigrant background, and gender. Adolescents from less affluent families and an immigrant background, particularly first-generation teens, participate in PA less frequently, and girls in general engage in PA less often than boys, thereby perpetuating gender inequality. These results highlight the need for specific interventions to comprehensively tackle these structural barriers in order to promote equitable and inclusive participation in PA by these population groups.

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Reliability of the Image Category Observation System in Opponent Sports (SOCIDA)

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Aerial view of a paragliding flight over autumn foliage. ©Adobe Stock. GreenMOM

Abstract

The Image Category Observation System in Opponent Sports (SOCIDA by its Spanish acronym) was developed to analyze body and gender stereotypes present in images from books and specialist manuals related to the group of opponent sports and, more specifically, to combat sports. The influence of stereotyped models in images on individuals' processes of socialization, perception and belief formation is profound and significant. The main aim of this study was to validate the SOCIDA observation system, which is structured into two dimensions, eight criteria and 15 categories. Validation was carried out using systematic observational methodology, including consensual agreement, expert judge review, observer training and analysis, and the assessment of intra- and interobserver agreement, thereby ensuring the reliability and generalizability of the results. The data were managed through a web application developed in PHP, an open-source server-side scripting language used for dynamic web applications, which facilitates collaboration, enhancement and customization of the tool according to users' needs. SOCIDA demonstrated high levels of agreement, internal consistency and reliability, with values of $\alpha = .841$ and $\kappa \geq .826$ as the mean across its items. It was concluded that this tool is suitable for physical activity teachers and researchers to identify and analyze body and gender stereotypes in images from opponent sports, contributing to a more critical understanding of the models represented in educational materials.

Keywords: body stereotypes, combat sports, gender stereotypes, observational methodology, teaching materials

Introduction

The issue of body and gender representation in sport has been addressed from various disciplinary perspectives, and highlights the need for intersectional approaches that consider multiple axes of inequality (Esposito & Evans-Winters, 2022; Vandellos et al., 2023). Gender, corporality, biological traits and disability interact in complex ways in the construction of social stereotypes, influencing both the experiences of athletes in these disciplines and the public perception of them. Abioye and Nyawo (2020) point out that gender-based structural barriers are deeply rooted in social culture, resulting in normalized forms of exclusion. In this context, intersectionality is essential to analyze how certain identities may be simultaneously rendered invisible or hypervisible, according to Crenshaw (1989) and Pape et al. (2023). Vandellos et al. (2023) underline the importance of considering the interaction between race, class, gender, sexual orientation and age. As a result, femvertising has emerged as an advertising trend that seeks to empower and challenge traditional stereotypes.

Combat sports have traditionally been regarded as masculine spaces that reproduce gender stereotypes, reinforcing traditional models of male strength and dominance (Channon & Phipps, 2017). When women enter these disciplines, they are confronted by a negative social imaginary that portrays them as violating conventional standards of femininity due to their strength, physique or physical expression (Gentile et al., 2018; Hartmann-Tews, 2019; Pastor, 2021). This issue is compounded by the way in which female athletes are depicted in the media and specialized manuals: less frequently, in static poses, with a focus on appearance, and rarely in competitive action (Juliet, 2024). In contrast, male athletes are usually portrayed in athletic performance contexts and occupy more visual space (Delorme & Testard, 2015).

Visual representation in sport is not neutral: it shapes identities, validates roles and contributes to the normalization of gender hierarchies. These images serve as powerful symbolic mechanisms that reflect and shape reality (Muñoz-Muñoz & Salido-Fernández, 2022). Consequently, the way in which women and men are visually and discursively represented in the sporting arena influences their professional and social recognition, and directly affects their identity (Gentile et al., 2018; Hartmann-Tews, 2019; Pastor, 2021).

According to Camerino et al. (2020), one of the key factors in reinforcing these social constructs is somatotype. The interaction between body biology and cultural gender ideals shapes how female athletes are perceived and valued. Andersen and Swami (2021) stress that these variables have a particular impact on adolescent girls, who are constantly judged based on their bodies. Tinoco et al. (2023) demonstrate how stereotypes related to skin color and body weight are common sources of ridicule and discomfort among female athletes, which can even lead them to abandon their sporting careers. This pressure stems not only from the male gaze, but also from the stigma attached to disciplines that are traditionally considered masculine, such as combat sport (Gentile et al., 2018; Channon & Matthews, 2018). One of the least explored aspects of this perspective is the intersection of gender and disability in sport. Paccaud and Baril (2021) point out that this relationship has only recently received attention in sport studies, despite its importance in understanding stigmatization dynamics. In combat sports, this situation is particularly acute, as gender acts as a determining factor in how participation is portrayed and valued (Paccaud, 2022; Calow, 2022).

Given this context, there is a need for rigorous analysis of the visual discourses found in teaching and promotional materials related to combat sports. This study addresses the factors that promote stereotypes through systematic observational methodology (Anguera et al., 2020), using a validated category system that enables the identification of key dimensions for analyzing visual representation.

Specifically, the study proposes the validation of the Image Category Observation System in Opponent Sports (SOCIDA by its Spanish acronym) (Ruiz-Sanchis et al., 2025). Although the tool has already been published in a specialist manual, its validation is necessary to ensure its reliability and relevance to its specific context of application. SOCIDA was developed based on previous work examining how the body is visually treated in sport (Muñoz-Muñoz & Salido-Fernández, 2022; Delorme & Testard, 2015). It provides a cross-cutting, intersectional reading of images found in sports books and manuals and incorporates variables related to technical, bodily and contextual representation.

The main aim of this study was thus to validate an observational tool designed to describe gender and body stereotypes in the images included in technical books and manuals on opponent sports. These materials contained technical-tactical, psychological, physical and regulatory content. The methodological approach adopted a critical and intersectional perspective in order to uncover visual patterns that reproduce inequality, invisibility and hierarchies in how bodies and genders are represented in the field of combat sports.

Methodology

The study was framed within an instrumental design based on observational methodology (Anguera, 1991), which enabled the structured, objective and sequential recording of observable behaviors in natural contexts.

The *ad hoc* tool, according to the typology proposed by Anguera et al. (2011), was classified as nomothetic, as it focused on the systematic comparison of multiple still images extracted from different sports manuals and books, allowing for the analysis of common patterns and divergences in visual representations. It was also cross-sectional, as it was limited to images captured at specific moments, and multidimensional, since it incorporated several analysis criteria related to technical, aesthetic and sociocultural aspects (Anguera et al., 2020).

A qualitative content analysis with an interpretative approach was used for data processing. According to Neuendorf (2017), this technique enables the identification and interpretation of the implicit meanings in visual material, based on the context in which it was produced, especially in relation to sociocultural values and possible stereotypes represented.

Sample

The sample consisted of 240 images (n = 240), with 120 representations per observer round. These were distributed equally, with 24 representations for each of the five combat sports analyzed: fencing, boxing, taekwondo, judo, and Olympic wrestling (men's and women's freestyle). This set of images represented approximately 2% of the total visual content available in the 36 selected books and specialized manuals. The images were selected through random sampling with structural representativeness criteria, ensuring the inclusion of all identified grouping types. Furthermore, the selected images covered the 15 categories defined according to the eight criteria established in the analysis system.

The sample consisted of 40 individual representations (33%), 50 paired (42%), 20 group (17%) and 10 mass representations (8%). The selected books and manuals had to meet the following inclusion criteria: 1) Specialized manuals that explicitly, systematically and orderly provide information for the initiation and improvement of performance in the sport modality, as well as instructions considered necessary for the execution of defined activities in the technical-tactical, regulatory, physical preparation and/or training support processes; 2) Manuals written in Spanish and English. 3) Manuals printed between 2012 and 2022.

Recording Tool

The observation tool used in this study was the Image Category Observation System in Opponent Sports (SOCIDA, by its Spanish acronym) (Ruiz-Sanchis et al., 2025). Although the tool had already been published, this study focused on its validation to ensure the methodological robustness of the collected data.

SOCIDA enabled the structured, systematic and multivariate recording of data and images related to the combat sports included in the Olympic programme for the Paris 2024 Games.

From a technical perspective, the SOCIDA platform was developed as a web application programmed in PHP, allowing online use from any device with internet access. The interface was designed to be simple, intuitive and operationally efficient, minimizing potential errors in the observers' recording and analysis process. The web application is accessible from the sub-domain http://freesocida.giepafs.net hosted on a virtual private server (VPS) with Linux operating system (CentOS 6.4). The platform was programmed in PHP (v.8.1) and uses a MySQL relational database (v.5.3.1), which enables the structured insertion, storage and management of observational data. This digital environment allows for continuous data updating, avoids duplication, and automates the storage of records, thereby improving the quality and reliability of the analysis. SOCIDA is structured into two dimensions (general and specific), eight criteria and 15 categories, designed to be exhaustive and mutually exclusive to ensure the reliability of the coding system and to facilitate subsequent multivariate analysis.

The registration and analysis process in the platform is conducted in two sequential phases:

First, the typological classification of the image, which considers the visual grouping based on the number of people depicted: individual (one person), paired (two people with clearly visible faces and/or full bodies), group (between three and 10 people in an organized sports practice setting), and mass (more than 10 people in the image).

Second, the coding of metadata and observational variables: an identification code is assigned to each image, along with additional variables such as the sport represented, publication year of the manual, image size, and use of color or black and white. These data appear in the user interface alongside the criteria and categories for analysis, thus facilitating the coding and review process by the observers.

Table 1 summarizes the criteria and categories for the general dimension, applicable to all images. Table 2 describes the criteria and categories for the specific dimension, differentiated by visual grouping type: individual, pair, and group. For pairs, items are duplicated to code the left and right figures, while for groups, items are subdivided by the number of men and women observed in each category. Table 3 presents the reduced set of 12 criteria and categories for the specific dimension applicable to mass groupings (more than 10 people), where coding is done using percentage approximation and binary detection of item presence.

Table 1
Overall dimension, criteria, categories and indicators of the SOCIDA tool

Criteria	Categories	Description
Characteristics of the image	Image size	Large: full page (A0) Medium: half page (A1) Small: a quarter of a page or less
	Color of the image	Black/white: absence of color Color: presence of at least 3 different colors.
	Part of the manual	First page: cover, spine, back cover, flaps Interior: courtesy leaf, main body
Characteristics of the context	Context	Competition: official event Training: performance in a non-competitive context Dissemination: sports/media promotion Various NR (not specified)

Note. NR = No response.

Table 2
Specific dimension: criteria and categories for individual, paired and group formats

Criteria	Categories	Description
Socio-demographic characteristics	Sex	Male: facial and/or body features Female: facial and/or body features NR (not applicable)
	Age	Childhood: 2-12 years Youth: 13-20 years Adulthood: 21-40 years Maturity: 41+ years NR (not applicable)
Physical characteristics	Body somatotype	Ectomorph: slender, tall, linear Mesomorph: muscular, athletic, powerful Endomorph: robust, broad, rounded NR (not applicable)
	Biological traits	Caucasian: fair complexion, light eyes, straight hair African: dark complexion, dark eyes, dark hair Asian: fair complexion, slanted eyes, straight hair Indigenous: copper complexion, dark eyes, dark hair NR (not applicable)

Note. NR = No response.

Table 2 *(Continuation)*
Specific dimension: criteria and categories for individual, paired and group formats

Criteria	Categories	Description
Characteristics of the activity carried out	Technical-tactical	With opposition: direct confrontation With object opposition: object confrontation Unopposed: absence of confrontation
	Regulation	Referee: main figure Material/equipment: referee-related or rule-based actions
	Physical preparation	Coach/trainer: main figure Material/equipment: training related
	Training support	Specialist: doctor, psychologist, physiotherapist Material/equipment: medical space and equipment
Characteristics of the function in the image	Function	Judge/referee: presides over the combat Athlete: takes part in the combat Coach: responsible for the athlete Others: public, supporters, family members...
Aesthetic characteristics	Aesthetics	Ornament: jewelry, bracelet, necklace, earrings Hairdressing: cut, color, hairstyles and accessories Make-up: modifying or highlighting facial features (lips, eyes, skin) Clothing: type, style and characteristics of clothing excluding sportswear Other: tattoos, painted nails, piercing Various None
Athlete with a disability	Adapted sport	Yes (clear practice of adapted sport) No

Note. NR = No response.

Table 3
Specific dimension, criteria and categories for mass grouping (>10 people)

Criteria	Categories	Description
Socio-demographic characteristics	Sex	Male (>60%) Female (>60%) Mixed (approx. 50% - 50%)
Characteristics of the activity carried out	Technical-tactical	Presence of sportsmen and sportswomen performing the sport
	Regulation	Presence of referees, judges or specific equipment
	Physical preparation	Presence of trainers
	Training support	Presence of doctors, psychologists, physiotherapists
	Historical	Philosophical-religious, historical or cultural elements
Characteristics of the function in the image	Function	Judge/referee: presides over the combat Athlete: takes part in the combat Coach: responsible for the athlete Others: public, supporters, family members...
Athlete with a disability	Adapted sport	Yes (clear Paralympic adapted practice) No

Note. NR = No response.

Data Quality Control

To validate SOCIDA, three expert judges were intentionally selected based on their professional and academic backgrounds. Inclusion criteria were: a) experience in the study of body and gender stereotypes in physical activity; b) over five years of experience in intersectional image analysis; c) experience as coaches or teachers familiar with specialized combat sports manuals.

This panel critically reviewed the tool's category system. Five basic criteria were used to evaluate the items—sufficiency, clarity, coherence, relevance, and effect—using a 4-point Likert scale. Qualitative and quantitative observations were provided for each unit, enabling adjustment and refinement of deficient items. This process enhanced content validity and ensured the tool's quality and relevance.

To ensure the reliability of the coding process, three observers were intentionally selected. Although two observers are sufficient according to Neuendorf (2017), this number was chosen to strengthen the study's methodological rigor. Selected observers met the following requirements: a) prior experience in intersectional image analysis research; b) work with illustrated images in the sports domain; c) access to the internet to participate online.

The observers demonstrated a high level of expertise in visual analysis of combat sports. Their experience facilitated coding and contributed qualitative judgements and insights that enhanced the analysis system.

Training Procedure and Reliability Calculation

The validation of the category system and agreement analysis involved several strategies. First, dimensions, criteria and categories were constructed based on documentary reviews and consensual agreement (Lapresa et al., 2021). Next, a descriptive manual-protocol of the tool was developed. The system was then reviewed by three expert judges. Subsequently, three observers were trained and tested in image analysis. Finally, intraobserver, interobserver and generalizability coefficients were calculated (Sastre et al., 2022).

Observer training consisted of a session where the category system was presented, doubts were clarified, and a subset of images (not included in the final sample) was coded. The aim was to standardize coding criteria and ensure operational understanding of the categories (Sastre et al., 2022). To evaluate interobserver reliability, Cohen's kappa index (Cohen, 1960) was calculated for dichotomous and presence/absence variables, and Krippendorff's alpha (Krippendorff, 2019) was used for nominal categories. Agreement values exceeded .80 across all categories, interpreted as "optimal" or "almost perfect" (Landis & Koch, 1977). These results ensured the consistency and reliability of the coding system. For intraobserver agreement, kappa values were calculated for the same observer at two different points in time (Table 4). The initial calculation showed a mean of .820, while the final one yielded .882 (Cohen et al., 2011), demonstrating high reliability.

Table 4
Intraobserver agreement, first and second round in the specific dimension

Criteria	Categories	Observation 1	Observation 2
Socio-demographic characteristics	Sex	.923	.947
	Age	.874	.856
Physical characteristics	Somatotype	.811	.824
	Biological traits	.831	.809
Characteristics of the activity carried out	Technical-tactical	.965	.966
	Regulation	.978	.981
	Physical preparation	.956	.977
	Training support	.956	.964
Characteristics of the function in the image	Role	.876	.881
Aesthetic characteristics	Aesthetics	.829	.833
Athlete with a disability	Adapted sport	.978	.981

Table 5
Interobserver agreement, first and second rounds

Observers	Intraobserver agreement 1	Interobserver agreement 2
Observer 1	.724	.768
Observer 2	.713	.735
Observer 3	.613	.657

To evaluate interobserver agreement, kappa was calculated based on the same situation observed independently by the three evaluators (Table 5). Two weeks later, the procedure was repeated, obtaining a mean kappa of .843, indicating a high level of agreement. As a complementary measure, Cronbach's alpha was also calculated to assess consistency among observers, resulting in a value of .737 (Losada & Arnau, 2000).

SOCIDA was adapted based on the data. When comprehension issues arose, some categories were revised and adjusted. After the modifications, observers reported improved global assessment of content validity and the adequacy of the criteria:

- In the "somatotype" criterion, specific guidance was added to differentiate the three possible levels.
- In the "age" criterion, four groups were defined based on age ranges: "Childhood" (2–12 years), "Youth" (13–20), "Adulthood" (21–40), and "Maturity" (41 and older).
- In the "aesthetics" criterion, the "Various" item was added.

These modifications are reflected in Tables 1, 2 and 3, which describe the criteria and categories.

The final phase involved analyzing data from the second round of observations to determine the system's reliability and stability with the data from the three observers. A total of 120 images were analyzed following the initial criteria, based on a new stratified, non-probabilistic sampling with synchronous observer participation.

Data Analysis

To validate the SOCIDA system, the statistical analysis of the data was performed using SPSS 26.0 and the SAGT v1.0 version 211 software (Hernández-Mendo et al., 2016) for generalizability analysis.

Cohen's kappa coefficient was applied for each criterion in the tool. In addition, overall pairwise comparisons between observers were conducted. The reliability of the quantitative scales across the three observers was adjusted using Fleiss' kappa. Subsequently, Cohen's kappa was applied for pairwise comparisons, complemented by a generalizability analysis using a two-facet design: observer/categories.

Results

Fleiss' kappa coefficient estimated values ranging from .701 to .962 for interobserver agreement and from .722 to .983 for intraobserver agreement among the three participants. These coefficients are shown in Table 6. The results indicated substantial agreement in the following criteria: image characteristics (.933), context characteristics (.857), performed activity (.885), function in the image (.912), aesthetics (.877), and person with disability (.961). All of them exceeded the value of .80, a threshold which, according to Landis and Koch (1977), indicates almost perfect agreement.

Table 6
Kappa values in the inter- and intraobserver test for SOCIDA

Criteria	Interobserver	Intra O1	Intra O2	Intra O3
Characteristics of the image	.933	.921	.912	.934
Characteristics of the context	.857	.844	.862	.823
Socio-demographic characteristics	.732	.848	.765	.729
Physical characteristics	.701	.765	.783	.762
Characteristics of the activity carried out	.885	.934	.922	.933
Characteristics of the function in the image	.912	.951	.987	.965
Aesthetic characteristics	.877	.871	.823	.831
Athlete with a disability	.961	.970	.981	.955

Table 7
Interobserver agreement analysis

Criteria	% interobserver agreement	Cohen's Kappa
Characteristics of the image	95.1%	.941
Characteristics of the context	91.5%	.906
Socio-demographic characteristics	69.2%	.671
Physical characteristics	70.3%	.627
Characteristics of the activity carried out	78.8%	.713
Characteristics of the function in the image	75.6%	.736
Aesthetic characteristics	82.5%	.812
Athlete with a disability	92.4%	.933

A group interobserver agreement analysis was carried out (Table 7). The variables image characteristic (κ = .941), the dimension "athlete with a disability" (κ = .933), and image context (κ = .906) obtained the highest kappa scores, reflecting a very high correlation. In contrast, the criteria of sociodemographic characteristics (κ = .671) and physical characteristics (κ = .627) yielded the lowest coefficients, indicating a moderate correlation strength.

With the data obtained, contrast tests were conducted to calculate the reliability of SOCIDA. In this second round, Fleiss' kappa coefficient was applied, yielding an intraobserver agreement ranging from .753 to .862, and an interobserver agreement from .721 to .880. The mean kappa value was .826, indicating a good level of agreement (Landis & Koch, 1977), and high, highly suitable reliability. Additionally, Cronbach's alpha was calculated as an indicator of observer competence, yielding a result of .841 (Losada & Arnau, 2000).

A generalizability study was conducted using a two-sided model: Criteria and Observers, under the C/O design, where the criteria acted as the differentiation facet and the observers as the instrumentation facet. The variability of each facet and their interactions was estimated, as well as the absolute and relative generalizability coefficients. Eighty-nine per cent of the variability corresponded to the criteria, 6% to the observers and 5% to the interaction. The overall generalizability index was .821, indicating a good fit and allowing the conclusion that the results can be generalized reliably.

Discussion

Specialist manuals on opponent sports—and more specifically, on combat sports—constitute a fundamental didactic resource both for initial and ongoing training of professionals in the field of sport. However, their long-lasting nature and frequent use by students and professionals make them significant vehicles for the transmission of cultural norms and social biases (United Nations Educational, Scientific and Cultural Organization, 2017). In contexts where gender or body stereotypes prevail, these tend to be integrated and reproduced in the visual and textual content of such manuals (Abioye & Nyawo, 2020). As a result, far from being neutral tools, these resources may contribute to the consolidation of prejudices, directly influencing the perception and education of future sport professionals. It is worth noting that the presence of such stereotypes can significantly impact the training of future physical education teachers and coaches, who may in turn perpetuate them among their students and athletes, thus generating negative effects and exclusionary situations—particularly for women and girls in sport (López & Pardo, 2021; Monforte & Úbeda-Colomer, 2019). It is therefore essential to identify the stereotypes present and analyze the characteristics and attributes of the people represented in these documents, as well as to describe the symbolic constructs that ultimately shape and define the roles assigned in sport (Martínez-Abajo et al., 2020; Lampert, 2018).

The aim of this study was to validate the Image Category Observation System in Opponent Sports (SOCIDA) (Ruiz-Sanchis et al., 2025), a tool designed to analyze and describe gender and body stereotypes present in the images of sport manuals and textbooks. The validation process focused on ensuring the reliability of the tool, starting from a design grounded in the relevant scientific literature and in consensual agreement (Lapresa et al., 2021). Special attention was also given to the training and selection of observers, to ensure high-quality standards both in their instruction and in the training procedures, contributing to the robustness and consistency of the data obtained.

The integration of an intersectional perspective (Crenshaw, 1989) is especially relevant, as it enables an analysis of how gender stereotypes interact with other axes of inequality—such as age, body type, race and disability—in the construction of image and recognition of participants in the sporting context (Esposito & Evans-Winters, 2022; Channon & Matthews, 2018). As evidenced in the literature (Vandellos et al., 2023), the visibility or invisibility of certain groups in educational and sports dissemination materials reflects normalized patterns of exclusion that particularly affect women, girls and people with disabilities (Gentile et al., 2018). In this regard, the analysis of the images using the SOCIDA system has enabled the identification of the reproduction of body and gender stereotypes, as well as the limited presence of diverse and inclusive models. This aligns with the need to address equal opportunities and coeducation through physical education and the training of future teachers. The interaction between somatotype, biological traits and gender stereotypes reinforces the pressure on female athletes, especially during formative stages, and generates negative effects on self-esteem, retention, and the development of their sports careers (Hartmann-Tews, 2019).

The SOCIDA tool has proven to be valid and reliable for identifying these patterns, as it enables a systematic and multivariate analysis of visual representations in sports-related materials (Anguera et al., 2020). Its application facilitates the auditing of content—especially images—from a critical perspective, and provides empirical data that can guide the revision and redesign of teaching resources and sports manuals towards more inclusive and equitable models. Its application allows the identification of visual patterns that reproduce inequalities, invisibility and hierarchies, thus facilitating the critical review of educational and dissemination materials that influence the social and professional perception of sport. The reliability achieved in the coding processes and the high inter- and intraobserver agreement reinforce the methodological consistency of the study (Losada & Arnau, 2000), and support the usefulness of the instrument for research in educational and professional contexts.

The tool aims to raise awareness among teachers, coaches and publishers about the presence of bias and stereotypes that may perpetuate exclusion—particularly of women, girls and people with disabilities—thus contributing to the training of professionals who are more aware and committed to equality and inclusion (Monforte & Úbeda-Colomer, 2019). It may also help improve the design and selection of visual representations that reflect real diversity, and promote alternative models that challenge traditional standards and enable all groups to see themselves represented in the field of sport (Delorme & Testard, 2015; Channon & Phipps, 2017). Moreover, it is suitable for promoting more egalitarian and respectful sports environments, as it contributes to the normalisation of body and gender diversity in the images that are part of physical and sports culture (Muñoz-Muñoz & Salido-Fernández, 2022), which can positively influence the motivation, self-esteem, and retention of historically marginalised groups.

In sum, SOCIDA is a suitable tool for reviewing visual narratives in opponent sports. It aims to support the development of an inclusive, diverse, and equitable sporting culture that responds to current social demands and fosters the full participation of all individuals, regardless of gender, physicality, or disability.

Conclusions

The results of this study show that the developed instrument has content validity and optimal reliability for identifying and analyzing body and gender stereotypes in images found in manuals and specialized books on opponent sports, with particular emphasis on combat sports. Its digital format and online accessibility facilitate collaborative work between coders, improve the traceability of the analysis, and optimize data management, thereby reinforcing its applicability in academic and professional contexts.

These features enable researchers, publishers, educational institutions, teachers, sports federations and public bodies to audit their visual materials and communication strategies from an equity perspective. Its use promotes greater critical awareness of the persistence of cultural and social stereotypes in training materials, helping to guide the design of more inclusive, representative and educationally valuable content.

Ultimately, SOCIDA is a functional tool that contributes to improving the quality and social responsibility of visual content in contemporary physical and sports culture.

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PHYSICAL EDUCATION

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The Hybridization of Pedagogical Models to Enhance Personal Responsibility in the Improvement of Physical Fitness in Adolescents

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Aerial view of a paragliding flight over autumn foliage.
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Abstract

The aim of this study was to examine the results in physical education of the year-long hybridization of the Personal and Social Responsibility Model, combined with four other pedagogical models—attitudinal style, cooperative learning, sport education, and health-based physical education—according to gender. The study analyzed the effects on students' motivation, intention to be physically active, satisfaction of basic psychological needs, and personal and social responsibility in secondary school students. A mixed-methods methodological design was used with a sample of 92 students (43 girls and 49 boys), divided into an experimental and a control group, aged between 11 and 13 years (M = 12.24; SD = 0.32). The instruments applied were the BREQ-3, IPA, BPNSE, and PSRQ questionnaires, along with a physical fitness test to assess the influence of hybridization. A repeated-measures multivariate analysis of variance (MANOVA) was conducted on the different variables according to time (pre-post), group (control and experimental), and sex, with a significance level set at $p < .05$. Significant results were found in relation to gender as female students in the experimental group showed improvements in all physical fitness tests, in controlled motivation, and in the intention to be physically active. Improvements were also observed in autonomy and responsibility in the entire experimental group, although these could not be supported by the PSRQ questionnaire. It is suggested that physical education teachers implement the hybridization of pedagogical models to meet the current needs of the teaching-learning process, in order to achieve meaningful and high-quality physical education.

Keywords: basic psychological needs, motivation, pedagogical models, personal and social responsibility model, physical education

Introduction

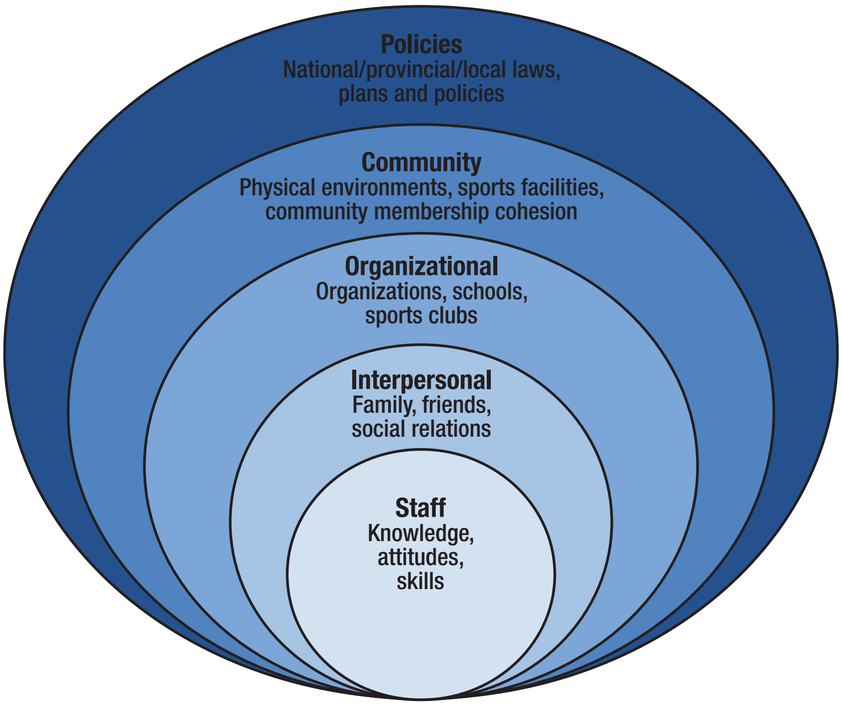
Currently, one of the issues that arise during adolescence, between the ages of 11 and 17, is the high prevalence of insufficient physical activity (PA). In Spain, 76.6% of adolescents do not meet the World Health Organization (WHO, 2020) requirement of engaging in at least 60 minutes of moderate-to-vigorous PA per day, despite the physical, psychological, and social benefits it provides (Barbosa-Granados and Urrea-Cuéllar, 2018; Ludick, 2018).

To reverse this situation, the WHO launched a Global Action Plan on Physical Activity (2019) aimed at achieving a relative 15% reduction in the prevalence of insufficient PA among children, adolescents, and adults. However, in order to be more effective when implementing an intervention, it is necessary to know and understand the factors that influence PA practice (Baena-Extremera et al., 2014). In other words, for an intervention to be effective, it must have an impact on multiple levels, since health is a complex concept involving multiple interconnected dimensions.

One of the approaches that addresses the interaction of different factors and levels is the socioecological model (McLeroy et al., 1988). This model suggests that health is not only the result of individual factors but also of social and environmental interactions. It is made up of five levels (Figure 1): personal (knowledge, attitudes, and skills); interpersonal (family, friends, school relationships); organizational (associations, sports federations, and cohesion with community members); community (physical environments, sports facilities); and public policies (laws, regulations, and plans at the state, regional, or local level).

Sicilia and Delgado (2002) highlight the need for the various stakeholders involved in the individual's overall development, such as the school, family, administration, or advertising, to work in a coordinated way. The educational field, and more specifically physical education (PE), has great potential to promote PA among young people, both directly—through the accumulation of PA minutes or positive experiences—and indirectly—by fostering the acquisition of a physically active lifestyle— (Slingerland & Borghouts, 2011). As a result, there is a push for exposure to quality PE, which stresses the importance of: "… equipping all children and young people with the competencies, aptitudes, attitudes, values, knowledge, and understanding needed for lifelong participation in society." (McLennan & Thompson, 2015, p. 6). As part of this new orientation, the term Meaningful Physical Education (MPE) has emerged, aiming to focus on how students perceive the subject and how to ensure this perception has a positive meaning in their lives (Fernández-Río & Saiz-González, 2023).

Figure 1
Socioecological model of levels of influence (McLeroy et al., 1988)



MPE and quality PE, together with the socioecological model, can help us create more effective, meaningful, and relevant PE programs for students, thus adapting the PE curriculum accordingly.

To create these programs, the use of pedagogical models (PM) is proposed. These are defined as: "Long-term approaches, complete extended learning situations (LS), which provide a comprehensive and coherent teaching plan to achieve specific learning objectives through plans, decisions, and actions consistent with a context and content" (Fernández-Río et al., 2021, p. 17). The main pedagogical models can be grouped into: a) basic models, such as cooperative learning, the Sport Education Model (SEM), the Teaching Games for Understanding model (TGfU), and the Personal and Social Responsibility Model (TPSR); and b) emerging models such as adventure education, motor literacy, the attitudinal style, the play-based technical model, the self-construction of materials, and health-related PE (Fernández-Río et al., 2016).

However, Pérez-Pueyo et al. (2021) argue that there is no single teaching model that applies to all knowledge or educational contexts, and therefore it is necessary to extract the most significant elements of each model and interrelate them, giving rise to an educational possibility with great potential. The use of different models jointly implies hybridizing them. The aim of hybridization is to find ways to adjust the teaching process to achieve the most appropriate and coherent learning for students. Meta-analyses on the hybridization of pedagogical models (González-Víllora et al., 2018; Shen & Shao, 2022) have shown improvements in physical and cognitive domains, sports technical skills, motivation, autonomy, as well as personal and responsibility skills.

With regard to gender, it has been observed that during adolescence sedentary behavior and sports dropout increase in females (Ribero et al., 2024). Studies have found that intrinsic motivation is more closely related to girls, while extrinsic motivation is more related to boys (Moral-García et al., 2019). In terms of perceived competency, girls assess their competency through internal and social sources, whereas boys do so in relation to competitive results and the ease of learning new skills (Murillo et al., 2014). On the other hand, several studies show higher levels of responsibility in boys compared to girls (Sánchez-Alcaraz et al., 2021), although there are studies that show the opposite (Gómez-Mármol et al., 2017).

The main objective of the present study was to examine the effects of hybridizing the TPSR (Hellison, 2011) in PE with other PMs—cooperative learning, health-related PE, attitudinal style, and SEM—compared to traditional methodology, according to gender, on students' motivation, intention to be physically active, satisfaction of basic psychological needs, and personal and social responsibility.

Methodology

Study Design and Approach

The study follows an action-research approach by implementing, throughout an academic year program (September to June), the hybridization of the TPSR with other pedagogical models such as the attitudinal style, cooperative learning, SEM, and health-related PE.

The methodology design applied was embedded mixed methods (Anguera et al., 2012), with multilevel triangulation indicating the two levels of data analyzed, derived from the quantitative and qualitative results of the different instruments used and later combined. The design was quasi-experimental, using pre-test and post-test measurements (Pérez-Juste et al., 2012).

Participants

The participant sample was intentional, selecting a standard public school in Catalonia, from a town near Barcelona, with a medium-low socioeconomic level. The total number of participants in this research was 92 secondary school students aged between 11 and 13 years (M = 12.24; SD = 0.32), consisting of 43 girls and 49 boys. They were distributed into five class groups, of which three belonged to the experimental group (28 girls and 32 boys), and the other two belonged to the control group (15 girls and 17 boys).

Instruments

Following the embedded mixed methods design, the instruments employed before and after the intervention (Table 1) can be divided into two groups of different nature: those that provided qualitative data, based on the recording and viewing of the sessions to evaluate teacher performance, group progress, and the writing of a researcher's diary on the intervention; and those that provided quantitative data obtained through questionnaires and physical fitness tests.

Table 1
Tests conducted during the intervention

Questionnaires	Intervention	Physical fitness test
BREQ-3	Hybridization of pedagogical models	Sit and reach
MIFA		Broad jump
BPNSE	Recording and viewing of sessions (TARE)	Medicine ball throw
PSRQ		Shuttle run

The observational records are not presented in this preliminary article, but it is important to highlight the attempt at triangulation throughout the process.

Behavioral Regulation in Exercise Questionnaire (BREQ-3): Instrument developed by González-Cutre et al. (2010) that measures the different types of motivation expressed in Self-Determination Theory (Deci & Ryan, 2000). It consists of 23 items introduced with the stem: "I exercise because…" in a 5-point Likert-type scale ranging from 0 (not true at all) to 4 (totally true). The items are grouped into intrinsic regulation, identified regulation, introjected regulation, external regulation, and amotivation.

Intention to be Physically Active (IPA): The version used was developed by Moreno et al. (2007), adapted for secondary school students. The questionnaire includes five items on a Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree), starting with "In my classes…".

Basic Psychological Needs in Physical Education Scale (BPNSE) (Moreno et al., 2008): It consists of 12 items grouped into three factors: autonomy, competency, and relatedness. The stem is "In my classes…", and responses are rated on a Likert scale from 1 (strongly disagree) to 5 (strongly agree).

Personal and Social Responsibility Questionnaire (PSRQ) (Escartí et al., 2011): It consists of 14 items distributed across two factors: social responsibility and personal responsibility. Responses are presented on a 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree).

Physical fitness test

In addition to the questionnaires, both at the beginning and the end of the intervention, a series of physical fitness tests were administered, included within the Eurofit battery (Conseil de l'Europe, 1983) and ALPHA-Fitness (Ruiz et al., 2011). The four fitness tests carried out were:

Sit and reach: From a seated position on the floor with legs extended and feet at 90º flexion placed against a box, participants were asked to slowly and progressively bend forward as far as possible with legs and arms extended. The final position had to be held for 2 seconds.

Medicine ball throw: This test consists of throwing the medicine ball as far as possible with both arms simultaneously, without moving the feet off the ground. The main objective is to assess explosive strength of the trunk extensors, upper limbs, and lower limbs.

Standing broad jump: This test measures musculoskeletal fitness (Ruiz et al., 2011). The participant stands with feet slightly apart behind the starting line. By flexing the legs and swinging the arms backward, they generate momentum, then perform a rapid extension of the legs while swinging the arms forward. Upon landing, participants must maintain their feet in the same spot where first contact was made, without losing balance.

Shuttle run: Designed to measure maximal aerobic power. Students run back and forth between two lines set 20 meters apart, changing direction at the pace indicated by an auditory signal, which gradually accelerates. The test ends when a student fails to reach the line in time for the second consecutive beep.

Qualitative data

Along with the questionnaires and physical fitness tests, the sessions conducted during the intervention were recorded and reviewed to evaluate the implementation of the hybridization of the TPSR model with the other four pedagogical models, as well as the progression of the different groups in relation to the responsibility levels.

TARE (Escartí et al., 2015): A rubric in which, at 3-minute intervals, the degree of implementation of each TPSR strategy is assessed. The strategies include: 1) modeling respect; 2) setting expectations; 3) providing opportunities for success; 4) fostering social interaction; 5) assigning tasks; 6) promoting leadership; 7) offering choice and voice; 8) involving students in assessment; 9) promoting transfer. Based on these recordings, the researcher's diary was written, documenting the evolution of each experimental group as well as the teacher's role.

Procedure

The implementation of the hybridization of TPSR with the four other pedagogical models mentioned above was carried out throughout a full school year, from September to June. The researcher contacted the school during the previous academic year to explain the objectives of the study and request their participation. In addition, all participants signed informed consent, either agreeing or declining, following the ethical guidelines of the American Psychological Association regarding consent, confidentiality, and anonymity of responses. Approval had been granted by the Research Ethics Committee (022/CEICGC/2022).

Students completed the questionnaires at the beginning and at the end of the intervention using an online form via Google Forms. The lead researcher was present to clarify any questions. The physical fitness tests were administered at the beginning and end during two physical education classes, in which each student performed three attempts, with the best performance recorded, except for the shuttle run, which was performed only once. Each test lasted approximately 20 minutes.

Following the initial tests, the intervention was carried out through the implementation of the different LS planned for each term. Teacher training included a detailed explanation of TPSR, its essential components (levels of responsibility, session structure, steps for implementation), and practical strategies. For the application of the hybridization of the TPSR, the sessions of the experimental group were recorded. The teacher met weekly with collaborating researchers to review the sessions using TARE (Escartí et al., 2015), evaluate TPSR implementation, and receive suggestions to improve subsequent lessons.

Both experimental and control groups followed the same curricular content and competencies, including traditional and popular games, colpbol, aerobic endurance, acrosport, striking and fielding & racket sports and challenge-based sports. However, the difference between the two groups was related to the methodology used during the classes. The experimental group followed the hybridization of TPSR with other pedagogical models, while the control group followed a traditional approach.

The classes were structured around the methodological pillars of TPSR (integration, shared responsibility, teacher-student relationship, and transfer) and its basic structure (awareness, responsibility in action, group meeting, assessment, and self-assessment) (Hellison, 2011). To these, elements of the pedagogical model being hybridized were added. The control group followed a traditional session structure (warm-up, main part, cool down), in which the teacher led the class and students had little involvement in decision-making. In Table 2, the main characteristics of each LS implemented during the intervention are detailed.

In the last weeks of the course, the final questionnaires were passed, physical condition tests were carried out to know the evolution generated by the intervention in the students and a group discussion was held with questions related to the implementation of the TPSR in the classroom.

Statistical Analysis

The IBM SPSS 30.0.0 statistical program was used for the analysis of the variables. Descriptive statistics were obtained for all the dimensions under study; outliers were identified using the Mahalanobis distance and internal consistency was evaluated with Cronbach's alpha coefficient. The great majority of the coefficients exceeded the reliability values of .70 that are considered acceptable, as in the IPA and BPNSE questionnaires. With regard to the BREQ-3 and the PSRQ, most factors exceeded reliability values of .70, while identified motivation and amotivation in the BREQ-3, and the social factor of the PSRQ were between .60 and .70, also considered acceptable according to Hu and Bentler (1999). To determine the effect of implementation, a repeated measures multivariate analysis (MANOVA) was performed on the different variables according to time (pre-post), group (control and experimental) and sex. The sex variable was taken into account as a variable that could influence the participants' responses. A significance level of $p < .05$ was established.

The following formula was used to calculate the self-determination index (SDI) (Vallerand, 1997): [(2* Reg. Intrinsic) + Reg. Identified + Reg. Integrated] - [(Reg. External + Reg. Introjected) / 2] - (2* Amotivation). Autonomous and controlling motivation were calculated using the following formulas: 1) autonomous motivation: intrinsic regulation + identified regulation; 2) controlling motivation: amotivation + external regulation + introjected regulation.

Table 2
Explanation of the main characteristics of each LS implemented during the course

Content	Sessions	Hybridized PM	Experimental group	Control group
Popular and traditional games	10-12 sessions	TPSR + Attitudinal style	In the first sessions, the teacher introduced a series of traditional and popular games. From the fourth session, pairs of students introduced games to their classmates. During the presentation of the games, comments were made about the dynamics, and variants were suggested to modify aspects that participants felt did not work well or could be improved. At the end of each game, the presenters were assessed through peer-, self-, and teacher-evaluations.	In each session, the teacher presented three games and introduced variants that he or she considered appropriate without taking into account the students' opinions.
Colpbol	10-12 sessions	TPSR + SEM	The Sport Education Model was used. Students were grouped into four permanent teams throughout the LS, with specific roles agreed upon within each group. The basic structure of a sports season was followed (preseason, regular competition, and final stage). At the end of the course, as a final activity, a tournament was organized between the different teams of each class.	In each session, the teacher presented three or four games to improve technical and tactical aspects.
Endurance	10-12 sessions	MRPS + health-related PE	This LS aimed to teach students to maintain a steady pace to improve endurance. To this end, they were set a collective challenge: for the whole class (collective scoreboard) to reach 250 km, which is the distance polar bears have to travel each year to survive due to the thaw caused by climate change. They had to complete this distance over the five stages planned during the LS and with sessions outside school hours. During the first sessions, the CALADU-CAPAS 2.0 program was used; later, students had to maintain a steady pace on their own. Each session was monitored with a heart rate monitor to track fluctuations. In order to promote healthy habits, a "health passport" was created with challenges students had to complete (sleep hours, PA outside school, healthy breakfast, etc.)	The teachers presented activities or games to work on endurance. No heart rate monitors or health passports were used.
Acrosport	10-12 sessions	TPSR + cooperative learning	In stable groups, in which each student had a role to perform (photographer, equipment manager, secretary…), during the first sessions they were asked to create ten figures where two, three, four, and five members of the group had to participate equally, and everyone had to rotate through the roles of photographer, spotter, top, and base. From the fourth session, each group had to prepare a performance to be presented to the class on the final day. This performance had to include at least 10 figures, with everyone rotating through the roles of base, flyer, and spotter.	The teachers planned the 10 figures to be performed in pairs, trios, quartets, quintets, and sextets. Students had two full sessions to complete the figures.
Striking and fielding & racket sports	10-12 sessions	TPSR + cooperative learning	Each group specialized in one striking and fielding & racket sport (tennis, table tennis, badminton, baseball, or hockey). Moreover, each member created a task for their sport, and then the group selected the activity they liked most. Once they had their final proposal, they shared it with the other groups, who practiced it.	Two sessions were dedicated to the practice of tennis, table tennis, badminton, baseball, and hockey. In this case, the teacher was responsible for proposing the activities to be carried out in the different sessions.
Physical and sport challenges	10-12 sessions	TPSR + cooperative learning	A similar approach to PACER (Performer and Coach Earn Rewards; Barrett, 2005) was followed. The teacher presented 15 physical and sport challenges, each with three difficulty levels. In each class, several challenges were set up in stations, with 15 minutes per station. Within each group, students helped each other complete the challenges, while the teacher checked their performance. If the whole group managed to complete a challenge at the highest level, they earned benefits for other challenges where they struggled more.	The same 15 physical and sport challenges were proposed, but in this case, students worked individually and could move on to the next challenge after completing one.

Results

The results were divided into two tables (Table 3 and Table 4); Table 3 shows the results of the physical fitness tests that were carried out; while Table 4 reflects the results obtained in the questionnaires. Both tables show the measures of the differences between the pre- and post-test, according to group and sex. Statistical significance values (*p* value) obtained when comparing these estimated measures (using the Bonferroni correction) are also included.

If we focus on the significant differences in relation to sex, in the girls, the group that received the MP hybridization obtained higher values at the end of the intervention in the sit and reach ($p = .001$), in the medicine ball throw ($p = .001$), in the standing broad jump ($p = .007$) and in the shuttle run ($p = .002$). On the other hand, the girls in the control group showed significant improvements in medicine ball throwing ($p = .001$) and in the standing broad jump ($p = .018$). The results for the boys were different. Significant changes were obtained in medicine ball throwing ($p = .016$), in the standing broad jump ($p = .016$) and in the shuttle run ($p = .001$) in the experimental group; while, in the control group, significant changes were obtained in the medicine ball throw ($p = .002$) and in the shuttle run ($p = .023$).

When analyzing the significant differences, relevant values were obtained in relation to controlling motivation between the girls in the experimental group and the girls in the control group. Girls in the experimental group showed higher values on the post-test (1.053; $p = .034$). Both groups (experimental and control) showed an improvement in IPA values when comparing the values obtained in the pre-test and post-test. With regard to the boys, it is worth noting the decrease in the personal and social component of the PSRQ, which led to significant differences between the pre- and post-test in favor of the group that carried out the program.

Table 3
Differences between pre-test and post-test according to sex and group (physical fitness test)

	Test	Pre-test		Post-test		Pre-post test differences	
		Boys	Girls	Boys	Girls	Boys	Girls
		Average	Average	Average	Average	*p* value	*p* value
Sit and reach	Control	–0.816	3.686	–1.984	5.615	.331	.129
	Experimental	–1.360	6.575	–0.299	9.789	.224	**<.001*** **
	p value	.799	.200	.460	.084		
Medicine ball	Control	467.277	428.399	510.276	491.688	**.002***	**<.001*** **
	Experimental	478.203	440.815	502.484	490.374	**.016***	**<.001*** **
	p value	.804	.688	.711	.968		
Broad jump	Control	151.889	122.003	150.943	131.855	.807	**.018***
	Experimental	155.557	139.251	162.432	147.439	**.016***	**.007***
	p value	.564	**.011***	.109	**.039***		
Course navette	Control	840.340	630.802	963.436	592.085	**.023***	.492
	Experimental	907.858	706.455	1,100.620	835.017	**<.001*** **	**.002***
	p value	.465	.435	.223	**.042***		

*$p < .05$; **$p < .01$; *** $p < .001$

Table 4
Differences between pre-test and post-test according to sex and group (questionnaires)

Test		Pre-test		Post-test		Pre-post test differences	
		Boys	Girls	Boys	Girls	Boys	Girls
		Average	Average	Average	Average	*p* value	*p* value
Autonomous motivation (BREQ-3)	Control	3.048	2.319	3.176	2.610	.460	.112
	Experimental	3.034	2.917	3.165	2.930	.294	.921
	p value	.949	.13	.968	.236		
Controlling motivation (BREQ-3)	Control	1.250	0.650	1.329	0.548	.685	.616
	Experimental	1.195	1.022	1.182	1.053	.928	.838
	p value	.823	.153	.513	**.034***		
SDI (BREQ-3)	Control	9.357	7.174	10.294	8.355	.236	.157
	Experimental	10.216	8.918	10.293	9.306	.892	.524
	p value	.451	.147	.999	.451		
IPA	Control	4.167	3.292	4.225	3.784	.706	**.003***
	Experimental	4.212	3.778	4.332	4.035	.283	**.033***
	p value	.869	.092	.674	.349		
Autonomy (BPNSE)	Control	3.401	3.051	3.656	3.227	.227	.427
	Experimental	3.700	3.545	3.554	3.445	.337	.539
	p value	.185	**.039***	.668	.386		
Competency (BPNSE)	Control	3.952	3.549	4.245	3.596	.082	.789
	Experimental	3.964	3.857	3.974	3.705	.934	.239
	p value	.955	.175	.213	.635		
Relatedness (BPNSE)	Control	4.270	3.817	4.249	4.033	.910	.283
	Experimental	4.091	4.330	3.948	4.151	.295	.217
	p value	.422	**.031***	.194	.618		
Personal (PSRQ)	Control	5.022	4.836	5.006	5.022	.900	.890
	Experimental	4.905	4.964	4.700	4.846	**.027***	.231
	p value	.397	.378	.092	.966		
Social (PSRQ)	Control	5.185	5.322	5.295	5.377	.410	.692
	Experimental	5.265	5.515	4.881	5.433	**< .001*****	.429
	p value	.603	.232	**.031***	.780		

*$p < .05$; **$p < .01$; *** $p < .001$

Discussion of Results

The results indicate that the students who received the TPSR model hybridized with other PM—the SEM, health-related PE, the Attitudinal Style, and Cooperative Learning—showed improvements in all physical fitness tests (sit and reach, standing broad jump, medicine ball throw, and shuttle run). This was the case for the girls, who achieved significant improvements in all the tests performed, as well as for the boys, who also improved except in the sit and reach. By contrast, the group that was taught through a more traditional methodology did not show improvements in the sit and reach test; however, in the other tests, both the girls and the boys improved. In their study, Melero-Cañas et al. (2021) hybridized the TPSR model with gamification and found improvements in the speed-agility test. Likewise, it is worth highlighting the article by Carcas-Vergara et al. (2024), who, despite not using a hybridization of PM, compared the ludotechnical model with the traditional one and obtained similar improvements in both.

These results suggest that hybridizing the TPSR model with other pedagogical models is just as effective as traditional methodology in terms of physical fitness. However, with the intention of adapting to new curricula, which propose placing students at the center of learning, it is advisable to move away from more traditional methodologies and approach more innovative ones.

One of the goals set by PE teachers is to increase students' PA practice, especially during adolescence. In our study, we observed that the group of girls, both in the control and experimental groups, showed an intention to be more physically active after the intervention. These results are similar to those reported by García-Castejón et al. (2021), who hybridized the TPSR model with TGfU, and not only achieved improvements in the IPA but also in psychosocial variables. Prat et al. (2019) argued that the use of the TPSR model generates a climate of greater participation, effort, commitment, and leadership, characteristics that foster more positive experiences in PE classes and, in turn, encourage more physical activity practice outside school hours. Merino-Barrero et al. (2020), for their part, also found that applying the TPSR model, compared to direct instruction, in secondary school improved students' intention to be physically active outside school.

On the other hand, regarding student motivation, the calculation of the SDI showed improvements in both groups, although in neither case were they significant. Valero-Valenzuela et al. (2020) observed that applying a hybridization of the TPSR model with gamification resulted in a decrease in amotivation and an increase in the SDI, just as García-García et al. (2023) found with regard to prosocial behaviors. Merino-Barrero et al. (2020) reported that applying the TPSR model could promote more self-determined motivation and reduce amotivation. Other authors who also found improvements in intrinsic and introjected motivation were Manzano and Valero-Valenzuela (2019), who applied the TPSR model in subjects other than PE. Jorquera-Jordan (2022), in a systematic review on the effect of the TPSR model on student motivation, concluded that the TPSR model is closely related to more self-determined forms of motivation. When analyzing the levels of motivation within the TPSR model, it is observed that they initially stem from a more external locus and gradually move toward a more internal locus. This evolution is reflected in the fact that at the beginning there are greater external rewards and more teacher control, whereas in the later levels supervision and rewards are reduced (García-González, 2021).

With respect to basic psychological needs (autonomy, relatedness, and competency), our study did not find significant improvements in any of the three. This differs from other studies such as that of Menéndez-Santurio and Fernández-Río (2017), who hybridized the SEM and the TPSR model, and found improvements in competency and relatedness, though not in autonomy. Similarly, Quiñonero-Martínez et al. (2023), through hybridizing the TPSR and SEM, reported progress in psychological needs. Prat et al. (2019) illustrated that applying the TPSR model generated a favorable perception among students regarding their basic psychological needs. The hybridization of game invention with the materials self-construction model (Méndez-Giménez & Garví-Medrano, 2025) fostered perceptions of autonomy, competency, and sense of belonging in the experimental group compared to the control group.

Finally, regarding the results obtained in the PSRQ, no significant improvements were observed in either of the two factors, despite the fact that activities were implemented where students had to help one another to achieve collective benefit. These results differ from those of other authors such as Manzano-Sánchez et al. (2019) or Pozo et al. (2018), who found improvements in personal and social responsibility after implementing specific programs based on the TPSR model. Llopis-Goig et al. (2011), for their part, recommend that for responsibility-development programs to be more effective, implementation should extend to other subjects and teachers. Wright and Burton (2008) also propose combining the questionnaire with other techniques, such as observation, in-depth interviews, or focus groups. In this case, it is worth highlighting that the students in the experimental group who participated in the TPSR model, once the implementation was completed, answered questions related to their personal and social responsibility. The majority responded that the model had allowed them to improve their responsibility when learning to work individually and in groups, thanks to the different methodologies applied throughout the year (e.g., group roles and expert groups).

Conclusions and Limitations of the Study

The aim of the study was to analyze the implementation of the TPSR model and its hybridization with other PM—the Attitudinal Style, Cooperative Learning, the SEM, and health-related PE—compared to traditional methodology, in relation to student motivation, intention to be physically active, satisfaction of basic psychological needs, personal and social responsibility, and performance in different physical fitness tests, as well as by gender. The results obtained show significant improvements in the experimental group in the different physical condition tests in both sexes, together with the intention of the girls to be more physically active. Therefore, the hybridization of PM, unlike traditional methodologies, allows placing the student at the center of the teaching-learning process, carrying out a more individualized education, adapted to the different contexts that can be found in the classroom. Furthermore, it has been observed that this approach enables the development of different subject-specific competencies and knowledge in PE, as well as transversal competencies that are fostered across all areas, subjects, and projects.

The ultimate goal is not only the acquisition of knowledge but also learning how to use it to respond to the main challenges students will face throughout life. To this end, it is important to design LS that present scenarios similar to those they may encounter in real life, influencing in a multicomponent and multilevel way to promote greater impact on students.

The main limitations of this study were, first, that the students had no previous experience with the implementation of pedagogical models in PE. Second, the teacher had little experience in applying the TPSR model and the other models with which it was hybridized, although they gradually evolved through observation and reflection on the sessions carried out with each group. Another limitation was that the teacher of the control group, besides being the PE teacher, also taught French. Finally, it would have been appropriate to analyze the effect of each hybridization separately, rather than the effect of the combination of all of them over the course of the academic year.

Future lines of research should consider the possibility of applying pedagogical hybridization in different secondary school grades and throughout the educational process, to see how it develops with age. Another relevant aspect would be to implement it in different educational contexts, such as schools with maximum complexity or post-compulsory studies, to assess whether it has the same applicability.

Practical Applications

Based on this study, it is recommended to hybridize different pedagogical models and to follow the practical guidelines below:

- Adapt pedagogical models to the specific context of each school, as every setting has its own needs.
- Try to ensure that the final outcome of each Learning Situation can be transferred to real-life contexts today and involve the different spheres of influence proposed in the socioecological model (e.g., accompanying a sedentary person, exploring the PA options available in the community, designing training programs for different fitness levels).
- Promote the acquisition of healthy habits throughout the academic year, for example, through a “healthy passport,” where students earn badges related to challenges (such as bringing a healthy lunch, participating in sports events, meeting recommended sleep hours, etc.).
- Provide a wide variety of knowledge/contents to be worked on, ensuring that they are as innovative as possible, given their direct relationship with student motivation.

By following these pedagogical recommendations, the aim is to foster a quality and meaningful PE for all students—in short, a PE that motivates them and helps ensure that, as adults, they will want to and know how to practice PA in their free time, while also maintaining healthy lifestyle habits that contribute to better health.

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Active Methodologies and Gender Equality in Physical Education: A Systematic Review

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Aerial view of a paragliding flight over autumn foliage.
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Abstract

Various studies have discussed the existence of gender inequality in physical education (PE) classes, pointing to lower motivation and participation among female students. It is essential to reflect on teaching practice to achieve a more equitable education free from gender stereotypes. Our objective was to perform a systematic review analyzing the influence of pedagogical models on gender equality in PE sessions in elementary and high school education, as well as to describe and analyze these interventions. For this purpose, a systematic review was conducted, based on the PRISMA method, using the databases Web of Science, Scopus, SportDiscus, and Eric, analyzing the scientific literature between 2000 and 2024 relating pedagogical models in PE with gender equality. A total of 521 articles were found, of which 16 studies were included after applying the inclusion and exclusion criteria. The findings indicated that active methodologies had a positive impact on the promotion of gender equality in physical education classes, with female students' motivation, participation, and commitment on a par with that of their male peers. The main conclusion of the research found that models such as Cooperative Learning, Teaching Games for Understanding, and certain hybrid models promoted a more equitable scenario, enhancing female students' satisfaction and involvement and positively modifying perception of them among their peers.

Keywords: gender education, gender equality, pedagogical models, physical activity pedagogy, physical education

Introduction

Gender Equality in Physical Education

Physical education (PE) represents a positive setting for addressing social needs (Baena-Morales et al., 2023) and integrating both social and personal aspects (Fernández-Rio, 2015; Manzano et al., 2020a).

In that regard, innovative trends in PE transcend solely motor-related content and aim to consolidate interdisciplinary learning and more comprehensive education for students based on perspectives such as neuroscience (Pellicer et al., 2015), new technologies (García et al., 2020), or active methodologies (Blázquez, 2017; León-Díaz et al., 2023). Furthermore, some of those innovations are based on simultaneous use of multiple perspectives to obtain better results and enhance the specific benefits of method, as is the case with hybrid pedagogical models (Guijarro et al., 2020).

On the other hand, within the scope of its 2030 Agenda, the United Nations (UN) has defined 16 goals related to achieving a fairer and more sustainable world. Those include Sustainable Development Goal (SDG) 5 "Achieve gender equality and empower all women and girls" (UN, 2015).

Multiple studies have discussed the unequal participation, interest, and motivation among female students in PE due to traditional teaching methods that reinforce stereotypes or emphasize physical qualities associated with the male sex (Arenas et al., 2022; Fernández-García et al., 2007; Llanos-Muñoz et al., 2022). On that topic, Blández-Ángel et al. (2007) offer a particularly illustrative example regarding stereotypes in physical activity and sports. They demonstrated how instrumental traits and activities related to strength, risk, endurance, or a higher level of aggression continue to be associated with the male sex, while affective and expressive traits and activities involving rhythm, expression, or flexibility continue to be associated with the female sex. The study also concluded that female students encounter significant obstacles to access the world of physical activity—traditionally associated with the male sex—and that both male and female students who manage to overcome stereotypes and access activities classified as of "the opposite sex" are subject to sexist comments (Blández-Ángel et al., 2007).

In light of these issues, the *Guía para una educación física no sexista [Guide to Non-Sexist Physical Education]* (Vázquez & Álvarez, 1996) and works by Fernández-García et al. (2007), and Sánchez Hernández et al. (2022) later on, had already identified the need to broach PE classes through a co-ed approach that eliminates the universal masculine archetype, corrects sexist stereotypes, and develops all qualities regardless of sex or gender (Fernández-García et al., 2007; Sánchez-Hernández et al., 2022; Vázquez & Álvarez, 1996). In that sense, certain aspects such as teacher training, language, and teachers' own beliefs and expectations of their students can impact whether PE is practiced with gender equality in mind or whether it perpetuates sexist stereotypes (Vázquez & Álvarez, 1996). Thus, it seems that some progress, albeit slow, has been made in overcoming certain stereotypes and beliefs regarding PE and gender, and there are coexisting realities that negatively affect both men and women (Alvariñas-Villaverde & Pazos-González, 2018). Along those lines, PE teachers' involvement is a deciding factor in reducing and eliminating gender stereotypes, as is the participation and engagement of female students in PE classes and the incorporation of physical activity into their everyday lives (Reyes et al., 2024).

To connect SDG 5 with PE, given the psychosocial possibilities (Baena-Morales et al., 2023; Fernández-Rio, 2015; Manzano et al., 2020a) and innovative approaches of the latter (Blázquez, 2017; León-Díaz et al., 2023; Pellicer et al., 2015), critical reflection is essential to achieving gender equality in education and eliminating stereotypes related to physical activity and sports (Arenas et al., 2022; Fernández-García et al., 2007; Martos-García et al., 2020; Sánchez-Hernández et al., 2022; Vázquez & Álvarez, 1996).

PE Teaching Methods and Models and Their Relation to Gender Equality

The methodologies used in PE classes, with their pedagogical complexity, play a crucial role in the teaching-learning process (Fernández-Rio et al., 2021). Active methods, models (Fernández-Rio et al., 2021), and/or methodologies that are student-centered and whose curricula are adapted to students' needs, abilities, and interests promote competency-based learning that fosters student autonomy and agency (Paños, 2017; Pérez-Pueyo, 2015; Pérez-Pueyo, 2010).

Likewise, different methods can impact student involvement considering that teacher engagement varies according to whether traditional or more participatory methods are used, with the focus mainly placed on students in the latter method (Hortigüela & Hernando, 2017, Méndez-Giménez et al., 2012; Pérez-Pueyo et al., 2020).

Multiple studies have shown how certain models, such as the Teaching Games for Understanding (TGfU) Model, foster gender equality. González-Espinosa et al. (2019) found that using this model in elementary school improved the performance of female students, compared to direct instruction. Cañabate et al. (2023) also showed that cooperative methodologies encourage equality, as opposed to competitive methods that tend to produce gender inequality.

Along those lines, Llanos et al. (2022) and Aparicio et al. (2024) pointed to improved motivation and reduced gender inequality when using the Sport Education Model and hybrid methodologies in high school settings. These results agree with other studies that address the need to tackle gender stereotypes in sports and physical activity (Amado et al., 2017; Gutierrez & García-López, 2012; Manzano-Sánchez et al., 2020b; Oliveros & Fernández-Río, 2022).

Therefore, the objectives of this study were as follows: 1) perform a systematic review to analyze the impact of pedagogical models on gender equality in PE classes in elementary and high school, 2) describe and analyze those interventions.

Method

Via a systematic review, this research analyzed studies on the impact of gender perspective-based teaching methodologies in PE classes using PRISMA (Page et al., 2021) and other systematic review guidelines (Moher et al., 2015).

Eligibility Criteria

The inclusion criteria were as follows: a) studies published between 2000 and July 2024; b) full text had to be available; c) systematic reviews and meta-analyses were excluded; d) written in English, Spanish, or Portuguese; e) experimental or quasi-experimental intervention; f) scientific studies focused on the effects of applying an active methodology or pedagogical model with a gender-based perspective; and g) conducted in elementary or high school students. We also checked the references of the selected articles to ensure our search was thorough.

Search Strategy

The systematic review followed the PRISMA guidelines (Page et al., 2021). We agreed to use the following search phrase: (pedagogic models OR teaching models OR educational models OR pedagogical models OR active approaches OR active methods OR active methodologies) AND (physical education) AND (primary education OR elementary education OR secondary education OR high school OR middle school) AND (intervention OR experimental OR quasi-experimental OR randomized controlled trial OR RCT OR controlled trial) AND (gender OR sex). We searched for articles across four databases (Web of Science, Scopus, SportDiscus, and Eric) from 1 June to 10 July 2024. After searching, any duplicate articles were removed.

Study Selection and Data Processing

The articles were selected after reviewing their titles and abstracts. We obtained a total of 521 records. We ruled out 505 and selected 16 articles that met the inclusion criteria, focused on active methodologies and their relationship to gender equality in PE (see Figure 1). We also reviewed the references of said articles but identified no additional eligible studies. Two researchers reviewed the manuscripts independently and resolved any discrepancies by consensus. If no consensus could be reached, a third expert person was consulted.

On the following page is a flow chart that visually describes the process used to select the articles included in the review (Figure 1).

Quality Assessment

We evaluated the quality of the 16 selected articles using the Standard Quality Assessment Criteria tool (Kmet et al., 2004). Two researchers rated each study for design, sample, methodology, analysis, and presentation, obtaining a final quality score.

The quality scores for the articles were expressed as percentages ranging between 0 and 100% and varied from .58 to .91. The raters' agreement was calculated using the intraclass correlation coefficient, resulting in a score of .853 ($p = < .001$), indicating a "good" agreement level (Koo & Li, 2016). After implementing the raters' agreement, a conservative cut-point was agreed on for article selection, resulting in the inclusion of studies with scores above 55%. The overall scores ranged between .58 and .85 (first reviewer) and between .61 and .91 (second reviewer).

Figure 1
Flow chart (PRISMA, 2020)

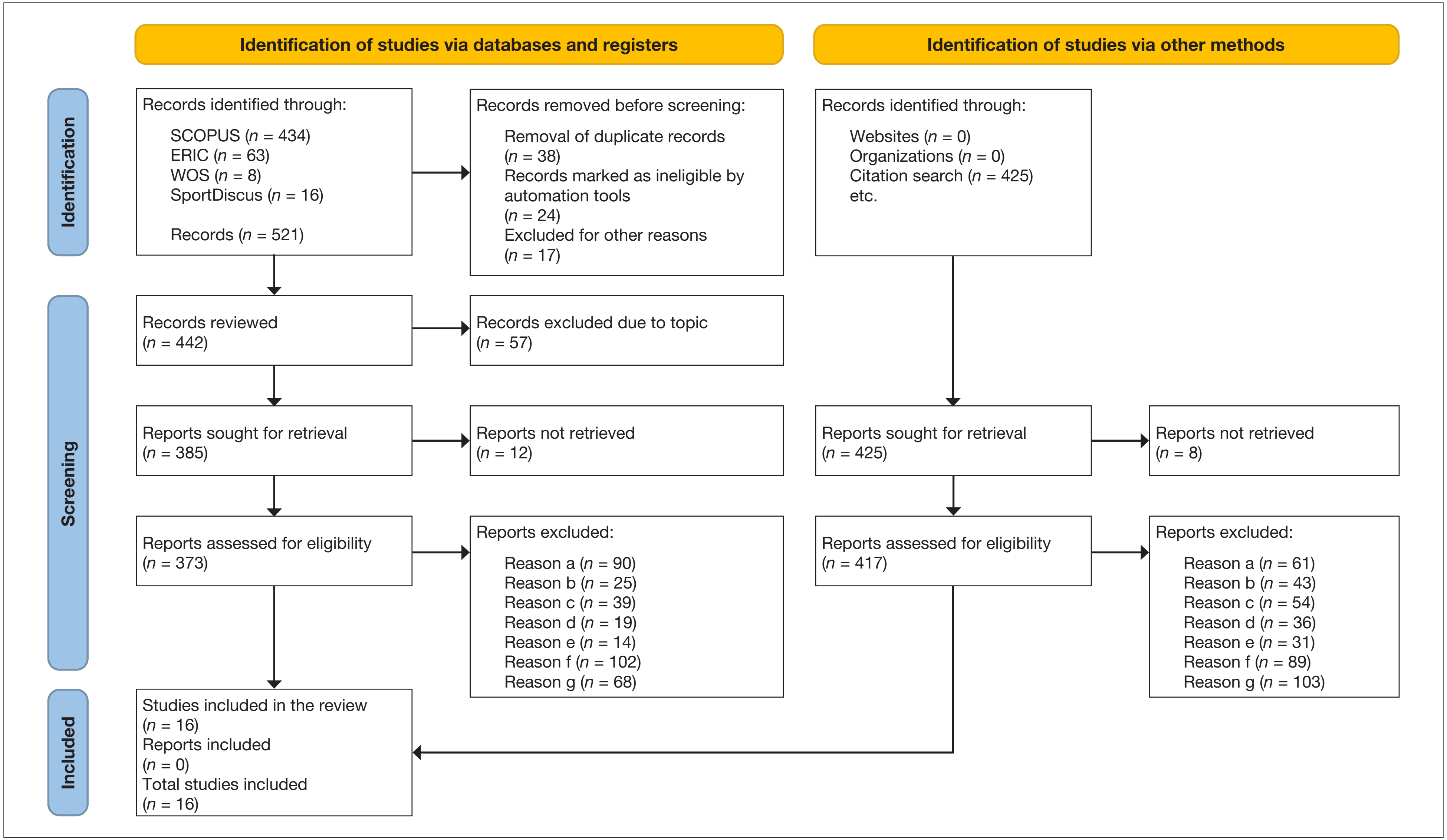

Table 1
Main characteristics of the analyzed research

Author(s)	Setting	Methodology Study type	Pedagogical model	Variables	Objectives	Primary outcomes
Gutierrez & García-López (2012)	Elementary school High school	Quantitative Experimental	Teaching Games for Understanding	• Offensive behavior	To evaluate gender differences in participation and offensive tactical behavior in invasion games with mixed teams in PE.	The results confirmed participation stereotypes in invasion games: male students focused on the ball and the goal while female students took on more passive roles. These differences, which are in line with prior studies, increase during adolescence.
Smith et al. (2015)	Elementary school	Quantitative Quasi-experimental	Tactical Games	• Health-related physical activity • Levels of physical activity • Motivation	To independently determine the levels of moderate-to-vigorous physical activity and the self-determined motivation of boys and girls during participation in units of invasion games with direct instruction and the Tactical Games Model.	Boys in the Tactical Games Model displayed significantly higher levels of physical activity in rugby and soccer, but no differences in motivation. The girls had similar levels in soccer but displayed lower activity levels in netball and no significant differences in motivation.
Amado et al. (2017)	High school	Quantitative Quasi-experimental	Learning with Dance (International Consortium of School and Art)	• Basic psychological needs for support and satisfaction • Intrinsic motivation • Identified regulation • Introjected regulation • External regulation • Amotivation • Usefulness • Enjoyment • Effort • Respect for facilities • Effort evaluation • Tolerance • Cooperation • Self control	To evaluate gender differences in motivational processes, and cognitive and behavioral consequences for the students after receiving a dance program based on creativity, support for autonomy, competence, and relatedness.	Significant differences were found (unrelated to the program) in the support perceived by the female students, who showed higher motivation, needs satisfaction, and more positive behavior towards dance as compared to the male students.
Sánchez-Hernández et al. (2018)	High school	Qualitative Experimental	Cooperative Learning	• Student roles • Class climate • Commitment to PE	To examine how student participation in a pedagogical intervention can transform understanding of gender, sexism, and social relations in PE.	The inclusion of critical pretexts on gender was important to the success of the intervention, providing a space for the female students to reflect on soccer and sexism, and for the male students to listen. Cooperative learning improved the classroom climate, enhanced engagement, and shifted attitudes towards the female students.

NR: Not reported.

Table 1 *(Continuation)*
Main characteristics of the analyzed research

Author(s)	Setting	Methodology Study type	Pedagogical model	Variables	Objectives	Primary outcomes
Burgueño et al. (2019)	High school	Quantitative Quasi-experimental	Sport Education	• Motivational regulation • Achievement goals • Social goals	To analyze the impact of the Sport Education Model on high school students' motivation, considering the effect of gender.	Significant differences were observed in students of both genders in terms of regulation, approach-mastery goals, and responsibility. Female students increased their introjected regulation, responsibility and relationship goals, and significantly reduced amotivation.
González-Espinosa et al. (2019)	Elementary school	Quantitative Quasi-experimental	Tactical Games Approach (TGfU) Direct instruction	• Game actions • Performance indicators	To analyze the differences in basketball learning according to the teaching-learning methodology and gender.	The male and female students, independent of gender, displayed better performance with the Tactical Games Approach. Furthermore, the female students presented significant differences after applying the model, showing that it is more beneficial for female students than for their male counterparts.
Manzano-Sánchez et al. (2020b)	High school	Mixed Quasi-experimental	Personal and Social Responsibility	• Satisfaction with the methodology • Values promotion • Grades	To evaluate how high school students and teachers perceive implementation of the Teaching Personal and Social Responsibility model, and its relationship with PE grades and gender differences.	Students and teachers positively evaluated the Teaching Personal and Social Responsibility model, highlighting the promotion of values and functionality. In terms of PE performance, no significant differences between the genders were observed, however the male students did display higher performance than their female counterparts.
Cañabate et al. (2021)	Preschool Elementary school	Qualitative NR	Cooperative Learning	• Positive interdependence • Individual responsibility • Promotive interaction • Acquisition of social skills • Group processing	To analyze the foundations of Cooperative Learning in the implementation of contextualized cooperative psychomotor physical challenges.	The activities carried out encouraged behavior related to altruism, care for classmates, value for diversity, gender equality, and cooperation.
Gil-Arias et al. (2021)	Elementary school	Quantitative Quasi-experimental	Teaching Games for Understanding Sport Education	• Supports autonomy • Satisfaction of BPNs • Autonomous motivation • Friendship goals • Satisfaction with PE	To research the motivational outcomes of elementary school boys and girls during a unit of invasion games through two pedagogical models.	Significant differences in student motivation were observed for both boys and girls who participated in the hybrid TGfU/Sport Education Model, which promoted an equitable and inclusive learning environment that encouraged engagement, enjoyment, and social interactions regardless of sex or the unit content.

NR: Not reported.

Table 1 *(Continuation)*
Main characteristics of the analyzed research

Author(s)	Setting	Methodology Study type	Pedagogical model	Variables	Objectives	Primary outcomes
Llanos-Muñoz et al. (2022)	High school	Quantitative Quasi-experimental	Sport Education	• Perceived inequality and gender difference • Satisfaction and frustration of the need for novelty • Self-determined motivation • Behavioral and emotional involvement in PE classes	To analyze the impact of a didactic unit of ultimate frisbee, based on the Sport Education Model, on the psychosocial variables of high school students, and to examine differences according to gender.	The results showed a significant reduction in perceived gender inequality, frustration, and demotivation, as well as increased satisfaction of novelty and behavioral and emotional involvement. Significant differences were observed between male and female students, which suggests that this model promotes an inclusive and equal environment in PE.
Oliveros & Fernández-Rio (2022)	High school	Quantitative NR	Hybrid model (Sport Education and TGfU)	• Level of participation in terms of physical activity	To investigate whether a hybrid pedagogical model can impact girls' in-class physical activity levels.	The results showed significantly lower scores for female students, low physical activity based on the assigned roles (playing vs. not playing), and the hybrid model increased participation among the older students. However, it did not help students achieve the recommendations for moderate-to-vigorous physical activity. Single-sex classes, specific sports, and social influences are discussed.
Cañabate et al. (2023)	Elementary school	Mixed Quasi-experimental	Cooperative methodology vs. Competitive methodology	• Participation in the activity • Throw quality • Motor skill level achieved when throwing	To look at gender differences in the efficiency of learning throwing as a fundamental motor skill using two different intervention methods: cooperative and competitive.	The results showed more notable differences between male and female students with the competitive methodology, though these decreased with the cooperative methodology. Both genders improved, with female students showing greater progress with the cooperative methodology, and male students improving with both methodologies.
Lamoneda et al. (2023)	High school	Qualitative with narrative analysis NR	Sport Education	• Satisfaction of basic psychological needs • Equal practice • Motivation • Satisfaction with performance	To evaluate an intervention program promoting gender equality in PE using a multidimensional methodology based on Self-Determination Theory, the Sport Education Model, and Socio-Critical Pedagogy.	The opinions of the teachers confirmed the efficacy of the It Grows program in achieving its objectives. In terms of gender equality, the students positively reported equal participation. It boosted equal participation and a reduction in sexist stereotypes. The mixed groups presented better social affective results.

NR: Not reported.

Table 1 *(Continuation)*
Main characteristics of the analyzed research

Author(s)	Setting	Methodology Study type	Pedagogical model	Variables	Objectives	Primary outcomes
López-Lemus et al. (2023)	High school	Quantitative Quasi-experimental	Sport Education Teaching Games for Understanding	• Motivation regulation • Satisfaction of basic psychological needs • Intent to stay physically active • Satisfaction with PE	To evaluate the effect of a mini handball didactic unit using a hybrid model (TGfU Model/Sport Education Model) as compared to Direct Instruction on motivation, satisfaction of psychological needs, motivation to stay physically active, and satisfaction with PE classes, with gender as a variable of interest in a co-ed environment.	The experimental group showed significant improvements in almost all the variables, reducing or eliminating any prior gender differences. Both genders presented similar levels of motivation, greater satisfaction with PE classes, and greater intent to stay physically active, promoting a more equitable environment.
Aparicio et al. (2024)	High school	Qualitative NR	Hybrid model (Sport Education, TGfU, Cooperative Learning)	• Gender equality • Alliances to achieve goals	To present a learning situation involving BigBall-X using a hybrid pedagogical model to promote gender equality and teamwork.	The students highly rated the BigBall-X situation for promoting gender and the creation of alliances, highlighting the lack of stereotypes and cooperative approach of the pedagogical models and alternative sports.
Cochon et al. (2024)	High school	Quantitative Experimental	Cooperative methodology (Jigsaw)	• Engagement levels in physical activity (sedentary, light, moderate, vigorous)	To investigate the effect of Jigsaw on moderate-to-vigorous PA in PE classes in light of student sex and habituation.	Moderate-to-vigorous physical activity was greater in the control group. Long sequences of Jigsaw improved female students' physical activity, proving it to be useful in minimizing inequalities in PE.

NR: Not reported.

Data Collection

The data from the selected articles were collected and verified in accordance with the PRISMA guidelines (Page et al., 2021). Two researchers with expertise in elementary and high school PE, psychosocial factors in education, and systematic reviews, evaluated the coding consistency, and achieved a 94% agreement level in the data extraction (González-Valero et al., 2019) by calculating the number of coincidences multiplied by 100 and divided by the total number of categories defined for each of the studies. This was then multiplied by 100 again.

Results

Study Characteristics

The study information was coded according to the following units of analysis: (1) Author(s), (2) Context, (3) Methodology/Study type, (4) Pedagogical model, (5) Variables, (6) Objective, and (7) Primary outcomes. The main characteristics of the analyzed studies are presented in Table 1.

These studies show that pedagogical models in PE influence both male and female students' participation and motivation, and that of female students specifically. The Tactical Games and Cooperative Learning models help close the gender gap, as shown in the study by Gil-Arias et al. (2021).

Along the same line, Sánchez-Hernández et al. (2018) pointed out that Cooperative Learning promotes enhanced participation by female students and improves male students' attitudes towards their female classmates, thus questioning gender relations. Cañabate et al. (2023) found that this approach promotes gender equality in PE.

Burgueño et al. (2019) reported that Sport Education improves female students' motivation, while López-Lemus et al. (2023) stated that a hybrid model minimizes gender differences and promotes greater satisfaction and more physical activity.

The studies suggest that collaborative and tactical pedagogical models may positively influence inclusive learning and the handling of gender inequality in PE, thus fostering respect, cooperation, and student potential.

The analysis shows how pedagogical models like TGfU and Tactical Games may encourage behavior and motivation on a gender basis, thus minimizing inequality through cooperative approaches and promoting gender equality.

Discussion

The objective of this study was to perform a systematic review to analyze the impact of pedagogical models on gender equality in PE classes in elementary and high school and to describe and analyze those interventions. In elementary school, it has been shown that models like Cooperative Learning and TGfU contribute to minimizing gender stereotypes and promoting equal participation, motivation, and performance between male and female students (Cañabate et al., 2021; Gil-Arias et al., 2021; Gutierrez & García-López, 2012). These methodologies help foster an inclusive environment and promote equal participation and motivation between the genders (Baena-Morales et al., 2023; Hortigüela & Hernando, 2017, León-Díaz et al., 2023; Méndez-Giménez et al., 2012; Paños, 2017; Pérez-Pueyo et al., 2020).

Though awareness of gender stereotypes in high school is increasing, inequalities persist in certain physical activities, as seen in higher engagement by male students compared to female students (Gutierrez & García-López, 2012; Sánchez-Hernández et al., 2018). Nevertheless, some studies reported improved motivation and involvement among female students after implementing models such as the Sport Education Model or hybrid models (Aparicio et al., 2024; Guijarro et al., 2020; Lamoneda et al., 2023; López-Lemus et al., 2023; Pérez-Pueyo et al., 2020), which relates to the importance of teachers' awareness of female students' participation in PE (Reyes et al., 2024).

On the other hand, we observed that gender stereotypes were upheld in some cases, with higher participation by male students than by female students (Gutierrez & García-López, 2012; Manzano-Sánchez et al., 2020b; Oliveros & Fernández-Río, 2022), or vice versa (Amado et al., 2017), depending on the specific physical activity. In that regard, we found a larger number of studies indicating both the upholding of stereotypes and a lack of impact from the model applied, which promoted male students' participation by 3 to 1 compared to models that promoted female students' motivation or interest. This may be related to what Blández-Ángel et al. (2007) found regarding the two large sets of traits presented and the perception of PE, which portrays the masculine archetype as universal (Arenas et al., 2022; Fernández-García et al., 2007; Vázquez & Álvarez, 1996).

Pedagogical models such as Cooperative Learning, Sport Education, and TGfU and their hybrids were identified as having a positive impact on gender equality in PE (González-Espinosa et al., 2019; Gil-Arias et al., 2021). These approaches helped foster a more inclusive and equal environment, encouraging participation and performance in both male and female students, which is in line with the current literature (Guijarro et al., 2020; Hortigüela & Hernando, 2017, León-Díaz et al., 2023; Méndez-Giménez et al., 2012; Pérez-Pueyo et al., 2020).

Based on the information presented above, we observed seemingly promising results regarding the impact of pedagogical models in PE to help achieve the SDG 5 "Achieve gender equality and empower all women and girls" and, therefore, help promote a fairer and more sustainable educational environment (UN, 2015). Nevertheless, we did identify some limitations in terms of the overall impact of the pedagogical models on moderate-to-vigorous physical activity in female students, who presented lower levels of engagement in physical activity, even when a hybrid model was used (Oliveros & Fernández-Rio, 2022).

Despite these promising findings, we observed certain limitations such as the lack of detail about the tasks performed and variability in the instruments and ages in the reviewed studies. The need for more in-depth research into specific variables was also apparent. Furthermore, it must be said that the idea to study pedagogical models in PE in relation to gender equality demonstrates the possibilities of these models but does not guarantee any improvement in this regard. The development of prosocial behavior in educational physical activity scenarios is thought to be shaped more by the adults responsible for the class than by the method used (Pelegrín et al., 2010). Fundamental variables in this sense include preparation, attitude, language, or hidden curriculum, as well as other aspects communicated by the teacher (Alvariñas-Villaverde & Pazos-González, 2018; Reyes et al., 2024; Sánchez-Hernández et al., 2022; Vázquez & Álvarez, 1996). Future lines of research could focus on the study of a single pedagogical model, or a single variable related to gender equality in PE. Likewise, it could be interesting to address reflection and critical thinking in PE, within the actual pedagogical models, as a transformative practice for gender equality.

Conclusions

After analyzing the reviewed studies, we can conclude that pedagogical models in PE influence performance and motivation in both male and female students and can also be useful for minimizing gender inequality. Models like Cooperative Learning, TGfU, and hybrid models (which pair these approaches with the Sport Education Model) promote an inclusive and equal environment, allowing male and female students to actively participate and improve their performance. In situations where female students present low participation, both the activities and environment must be adapted to promote gender equality.

Cooperative and tactical models increase female students' motivation and satisfaction, but also shift male students' perceptions of them, helping female students feel more valued and empowered in what is a traditionally male-dominated space. These approaches minimize the gender differences observed in competitive settings. The Sport Education Model and the TGfU Model contribute to reducing demotivation and foster the intent to stay physically active in the long term. Likewise, we must mention that pedagogical models in PE do not guarantee that gender equality will be achieved, as they must be implemented correctly and with a critical eye. In that regard, methodology is one of the keys to increasing gender equality in PE but it does not guarantee it alone. Nor should it be considered the only relevant factor when aiming to achieve greater gender equality in PE environments.

The main practical application of the study involves implementing models based on cooperation and tactical games, as these offer a clear opportunity to improve students' learning experiences and to foster an environment in which both male and female students can participate equally. This will help contribute to the students' overall development in terms of physical, cognitive, social, and emotional abilities.

Therefore, ongoing teacher training and adapting curricula according to these methodologies are essential to guaranteeing inclusive and effective PE experiences that meet the needs of all students, regardless of gender.

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Application of Indirect Observation in High-Performance Judo From a Mixed Methods Perspective

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Aerial view of a paragliding flight over autumn foliage.
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Abstract

This study analyzed, for the first time, the application of indirect observation to high performance judo, covering both male and female categories. Indirect observation involves, to a large extent, the analysis of textual material generated secondarily from transcriptions of verbal behavioral records, such as interviews. The aim of this study was to apply this methodology to the field of elite judo in order to explore the existence of communicative patterns related to technical and tactical adaptations to the opponent, aimed at achieving IPPON. Nine in-depth interviews were conducted with the following participants: Olympic judokas (n = 3), strength and conditioning coach of an Olympic judoka (n = 1), judo instructors in the Bachelor's Degree in Physical Activity and Sports Sciences (n = 3), and club coaches (n = 2). These interviews were analyzed by means of indirect observation through a quantitizing process based on the construction of an *ad hoc* observation instrument. The transcripts were segmented into textual units and a code matrix was elaborated that allowed a polar coordinate analysis to be carried out. This analysis facilitated the detection of communicative patterns related to the behavior "technical and tactical adaptations based on the opponent". The results showed statistically significant associations between these adaptations and variables such as standing judo and judo groundwork, dominance in *kumikata*, the time period of the match, and the score. The use of indirect observation proves to be a valuable tool for future studies focused on gathering athletes' perspectives and contributes to giving scientific value to their views on various aspects of the sport.

Keywords: interviews, judo, observational methodology, quantitizing

Introduction

Indirect observation is a relatively new concept within systematic observation (Anguera & Hernández-Mendo, 2016; Anguera et al., 2018), which falls under a broader paradigm, namely mixed methods (Castañer et al., 2013). It focuses on the analysis of textual material that is generated indirectly from transcriptions of audio recordings in natural contexts, such as conversations or group discussions, or directly from narratives such as complaint letters, interviews, or forum posts. This type of material represents a highly important data source, and its availability is constantly expanding thanks to new technologies that facilitate the capture, dissemination, and storage of data (Anguera et al., 2017).

What distinguishes indirect observation from other methodologies used to study opinions (such as Grounded Theory, discourse analysis, or thematic analysis) is its mixed qualitative-quantitative approach, in which the development of an observation instrument based on a category system enables a more objective and structured coding of discourse (Iván-Baragaño et al., 2023a). This makes this methodology optimal when seeking to analyze verbalizations from a systematic perspective.

The application of indirect observation offers a rigorous and systematized perspective to analyze verbal discourses through textual units and their subsequent coding (Anguera et al., 2018). It allows converting qualitative information into observable and analyzable data with quantitative criteria and provides objectivity and replicability to the analysis of opinions. Indirect observation not only allows us to capture the manifest content of the discourse (forums, interviews...), but also patterns, regularity and relationships between dimensions of analysis that would not be detectable with descriptive methods.

Although it has been successfully applied in other fields (García-Fariña et al., 2018; Alcover et al., 2019; Arias-Pujol & Anguera, 2020; Del Giacco et al., 2020; Alvarado-Álvarez et al., 2021), it is in the field of sport where it has gained the most traction (Sarmento et al., 2014; Sarmento et al., 2020; Nunes et al., 2022; Iván-Baragaño et al., 2023a). Traditionally, sports scientists have focused on data obtained through direct observation of behaviors (either in situ or through video/audio recordings), based on a direct observation strategy (Gamero-Castillero et al., 2022; Maneiro, 2021; Barbero et al., 2024). In contrast, indirect observation has enabled the scientific validation of the voices of athletes and coaches, offering insights into their opinions on various technical and tactical-strategic aspects of sport.

Within the field of team sports such as basketball, the study by Nunes et al. (2022) asks various high-performance coaches about the effectiveness of the pick & roll. The interviews revealed varying levels of confidence in this tactical element as an offensive resource. Coaches viewed the pick & roll as a key action for generating advantages, which allowed them to analyze the opponent and decide whether to finish the play or continue with the established offensive plan.

In men's soccer, Sarmento et al. (2014) interviewed eight coaches from the Portuguese league about the most important variables influencing attack. Although the coaches' assessments varied, all concluded that the choice of attack type (in this case, the counterattack) is directly related to the type of players, defensive style, and the zone where the ball is recovered. Furthermore, in another study, Sarmento et al. (2020) analyzed coaches from AS Monaco and concluded that the findings from direct observation were consistent with the information provided in the interviews—both regarding the importance of certain players within the team structure and the overall game system. They also emphasized that cooperation between scientists and coaching staff should be implemented regularly. Finally, in the context of women's soccer, Iván-Baragaño et al. (2023a) interviewed eight professional Spanish female players and coaches and found that the interview results suggested a statistically significant association between success in women's soccer and various tactical-strategic criteria—results that aligned with those obtained through direct observation (Iván-Baragaño et al., 2021; Iván-Baragaño et al., 2023b).

In short, the inclusion of indirect observation based on interviews with sports professionals provides valuable information for gaining a more comprehensive understanding of competitive reality and complements data obtained through direct observation. Therefore, the aim of this study was to determine which criteria influence technical and tactical adaptations based on the opponent, based on semistructured interviews with judokas, coaches, strength and conditioning coaches, and judo instructors in the Bachelor's Degree in Physical Activity and Sport Sciences.

Method

Design

To carry out this study, the observational methodology was applied (Anguera, 1979), based on the transcription of in-depth interviews conducted with coaches and judokas. The design was nomothetic—multiple units of study—, punctual—a single session, although with intrasessional follow-up—, and multidimensional—multiple levels of response, as reflected in the observation instrument— (Anguera et al., 2011). The protocol proposed by Portell et al. (2015) was followed to strengthen the methodological structure of the article.

Due to incomplete perceptibility of the object of study, indirect observation was used (Anguera et al., 2018), within the mixed methods paradigm (Anguera et al., 2021), to analyze transcribed oral behavior.

Participants

A total of nine interviews were conducted to gather the opinions of: Olympic judokas (n = 3), the strength and conditioning coach of an Olympic judoka (n = 1), judo instructors in the Bachelor's Degree in Physical Activity and Sport Sciences (n = 3), and club coaches (n = 2). All interviews were conducted in 2019 and 2020.

Based on these criteria (Anguera, 2003), the nine interviews conducted in this study were semistructured (the questions followed a flexible guide that allowed the interviewer to adapt to the flow of the conversation), non-directive (the questions followed a natural course and focused on the interviewee, allowing them to freely express their ideas, emotions, and experiences), and were conducted in person and individually, with a research purpose. To this end, the interviewer traveled to the different locations agreed upon with the interviewees. The interviews were also recorded using electronic devices in order to ensure optimal interpretation of speech and comprehension of language (data, discursive aspects, narratives, interwoven stories, etc.). The intensive nature of the study (gathering extensive data from each case) meant that although the number of interviews was small, a large amount of detailed and rich information was obtained from each one. Therefore, each interview became a complex case with multiple dimensions and analyzable data for indirect observation studies. The number of interviews was considered sufficient for this study, as in others (Iván-Baragaño et al., 2023a; Sarmento et al., 2020).

On the other hand, the inclusion criteria for selecting the experts interviewed were: being or having been a high-performance athlete in judo, being a judo teacher or coach, being part of the Spanish Judo Federation's coaching staff, being a scientific researcher in the field of judo, or being the strength and conditioning coach of high-performance judokas.

Instruments

Semi-structured interviews

Each of the interviews consisted of a total of 26 questions. Its design was based on three criteria: technical aspects of high-performance judo, tactical aspects and spatial-temporal management during matches. Once the interviews were conducted, they were transcribed into Microsoft Word documents. Following transcription, and as noted by Anguera (2020), the next step was to "liquefy the text." The textual material was segmented into textual units to systematize the information, facilitate its analysis, and enhance its significance. In this study, segmentation into textual units followed orthographic and syntactic criteria, with the same purpose of systematizing the information, enabling its analysis, and adding significance. After coding the textual units for quantitative treatment and consulting the theoretical framework, the indirect observation instrument was constructed.

Indirect observation instrument

The indirect observation instrument designed for this study was developed using an *ad hoc* approach that combined two perspectives: a bottom-up approach, based on the responses obtained and their relation to the theoretical framework and regulations, and a top-down approach, starting from the theoretical framework and cross-checked with the interviewees' responses. Its development involved a gradual process of refinement and specification of the dimensions and subdimensions that compose it.

The final instrument adopted a mixed format, combining a field format with category systems, which allowed for an effective approach to the high complexity of the phenomenon under study (Caprara & Anguera, 2019; Iván-Baragaño et al., 2023a). It was structured into 7 dimensions and 13 subdimensions. From some subdimensions, behavior catalogs were created and organized into open lists, ensuring mutual exclusivity of the items. Other subdimensions were used to build category systems based on theoretical frameworks, meeting the criteria of exhaustiveness and mutual exclusivity.

For each category and behavior included in the instrument, detailed descriptions were provided, accompanied by examples and counterexamples derived from the participants' responses. The indirect observation instrument, named the IndirectJudoBS Observation Instrument, is presented in Table 1.

Table 1
IndirectJudoBS Observation Instrument

Dimensions	Subdimensions	Categories	Code	Description
1. TECHNIQUE AND TACTICS	1 - Technical predominance in standing judo and judo groundwork situations according to weight category, sex, and/or age.	1.1 Existence of technical predominance.	A1SIPRETEC	The potential technical predominance in standing judo and judo groundwork situations based on weight category, sex, and/or age.
		1.2 Absence of technical predominance.	A2NOPRETEC	
		1.3 Only in standing judo situations.	A3PRETECJP	
	2 - Technical and tactical patterns in current judo.	2.1 Presence of technical and tactical patterns.	B1EXMOD	The possible existence of technical and tactical patterns/trends in current judo.
		2.2 Lack of technical and tactical patterns.	B2INEXMOD	
2. JUDOKA BEHAVIOR	3 - Technical and tactical behavior based on the opponent.	3.1 Technical-tactical adaptation.	C1ADAPTRI	Technical and tactical behavior based on the opponent.
		3.2 Maladaptation.	C2INADAPTRI	
		3.3 Based on the situation.	C3AMBONIN	
	4 - Intention of the judoka during matches.	4.1 Proactive.	D1PROAC	Intention of the judoka during matches.
		4.2 Reactive.	D2REAC	
	5 - Feints or deceptions during matches.	5.1 It is important to simulate the actual tactical intention.	E1AMG	The use of feints and deceptions during matches.
		5.2 It is irrelevant.	E2NOAMG	
	6 - Technical and tactical behavior in situations of score disadvantage and end-of-match timing.	6.1 Successful technical-tactical behaviors.	F1EXITECTA	Possible technical and tactical behavioral responses in situations of score disadvantage and with time running out.
		6.2 Specific repertoire.	F2REPERT	
		6.3 Repeated technical-tactical scheme	F3MISMESQ	
3. TATAMI	7 - Zoning of the tatami during judo matches.	7.1 Multiple zones.	G1DIFZON	The possible existence of optimal working zones on the tatami.
		7.2 A single zone.	G2UNAZON	
4. TIME PERIODS	8 - Most decisive time periods during judo matches.	8.1 Initial and/or final periods.	H1INFINPER	Most decisive time periods during a judo match.
		8.2 Central periods.	H2CENPER	
		8.3 All periods.	H3TODPER	
		8.4 All except the initial period.	H4EXCINPER	
5. *KUMIKATA* (GRIP FORM)	9 - Variants in *kumikata* (grip form).	9.1 A *kumikata* and its variants.	I1VARKUM	The importance of *kumikata* (grip form) variants.
		9.2 A *kumikata*.	I2UNKUM	
	10 - *Kumikata* (grip form) in situations where the opponent hinders its execution.	10.1 Imposing of the actual *kumikata*.	J1IMPAG	Behavior related to *kumikata* when the opponent hinders its execution.
		10.2 Adaptation to the opponent's *kumikata*.	J2AGRIV	
		10.3 Based on the situation.	J3IMOADAP	
6. GROUND-BASED JUDO	11 - Standing-to-ground transitions during judo matches.	11.1 Transitions are essential.	K1TRANSPS	The importance of standing-to-ground transitions during judo matches.
		11.2 Transitions are unimportant.	K2NOTRANSPS	
	12 - Positions from which to work in judo groundwork situations.	12.1 Movement from an individualized position and starting from the grip.	L1POSIND	Positions from which to work in judo groundwork situations.
		12.2 From a supine position.	L2POSSUP	
		12.3 From a quadruped position.	L3POSCUA	
		12.4 Based on the receiver or performer's position.	L4POSRECEJ	
7. JUDOKA REQUIREMENTS	13 - Requirements a judoka must meet to achieve success.	13.1 Psychological, physical, technical and tactical requirements.	M1PSFTECTAC	Requirements a judoka must meet to achieve success.
		13.2 Strategic, physical, technical and tactical requirements.	M2ESTRFTT	

Recording tool

The free software Lince Plus (Soto-Fernández et al., 2021), which is highly applicable in observational methodology, was used to record and code the textual units analyzed.

The use of this software allowed the recording, coding and subsequent export of the code matrix obtained to the formats required for subsequent analysis.

Procedure

Data quality control was conducted through the adaptation of Cohen's kappa coefficient (1960), following Krippendorff's (2013) proposal, to the canonical agreement coefficient. The reliability of the recording was assessed using Cohen's kappa coefficient (1960) in its intraobserver modality, yielding a value of 1 (Table 2), which is considered appropriate in the context of this study (Landis & Koch, 1977). In addition, the consensual agreement method (Lapresa et al., 2021) was used as a qualitative procedure for data quality control. This was carried out by three of the researchers participating in the study. The process consisted of three recordings (textual unit segmentation and coding) using the same indirect observation instrument and applying the intraobserver modality. Following the recommendations of Anguera (2020), three recordings were deemed appropriate, as indirect observation poses a higher risk of interference and subjectivity compared to direct observation. After transcribing the recorded interviews, they were segmented into textual units based on orthographic and syntactic criteria (Krippendorff, 2018).

These units were recorded and coded using indirect observation, a process that involved the quantitizing of the data (Anguera, 2020; Anguera et al., 2021). That is, the qualitative data obtained from the interviews were coded using the observation instrument, allowing for the generation of a code matrix (Table 2). This matrix facilitated the subsequent application of a robust quantitative analysis.

Table 2
Intraobserver agreement

Categories	Codes	Intrao1 Intrao2	Intrao1 Intrao3	Intrao2 Intrao3
1.1 Existence of technical predominance.	A1SIPRETEC			
1.2 Absence of technical predominance.	A2NOPRETEC	.87	.87	1
1.3 Only in standing judo situations.	A3PRETECJP			
2.1 Presence of technical and tactical patterns.	B1EXMOD	.73	.73	1
2.2 Lack of technical and tactical patterns.	B2INEXMOD			
3.1 Technical-tactical adaptation.	C1ADAPTRI			
3.2 Maladaptation.	C2INADAPTRI	.67	.67	1
3.3 Based on the situation.	C3AMBONIN			
4.1 Proactive.	D1PROAC	.87	.87	1
4.2 Reactive.	D2REAC			
5.1 It is important to simulate the actual tactical intention.	E1AMG	.87	.87	1
5.2 It is irrelevant.	E2NOAMG			
6.1 Successful technical-tactical behaviors.	F1EXITECTA			
6.2 Specific repertoire.	F2REPERT	.87	.87	1
6.3 Repeated technical-tactical scheme.	F3MISMESQ			
7.1 Multiple zones.	G1DIFZON	.87	.87	1
7.2 A single zone.	G2UNAZON			

Table 2 *(Continuation)*
Intraobserver agreement

Categories	Codes	Intrao1 Intrao2	Intrao1 Intrao3	Intrao2 Intrao3
8.1 Initial and/or final periods.	H1INFINPER			
8.2 Central periods.	H2CENPER	.87	.87	1
8.3 All periods.	H3TODPER			
8.4 All except the initial period.	H4EXCINPER			
9.1 A kumikata and its variants.	I1VARKUM	.87	.87	1
9.2 A kumikata.	I2UNKUM			
10.1 Imposing of the actual kumikata.	J1IMPAG			
10.2 Adaptation to the opponent's kumikata.	J2AGRIV	.87	.87	1
10.3 Based on the situation.	J3IMOADAP			
11.1 Transitions are essential.	K1TRANSPS	.87	.87	1
11.2 Transitions are unimportant.	K2NOTRANSPS			
12.1 From an individualized position and starting from the grip.	L1POSIND			
12.2 From a supine position.	L2POSSUP	.87	.87	1
12.3 From a quadruped position.	L3POSCUA			
12.4 Based on the receiver or performer's position.	L4POSRECEJ			
13.1 Psychological, physical, technical and tactical requirements.	M1PSFTECTAC	.87	.87	1
13.2 Strategic, physical, technical and tactical requirements.	M2ESTRFTT			

Data analysis

To construct a map of interrelations between different behaviors, a polar coordinate analysis was conducted (which has also been applied in other studies on indirect observation in sports, such as Sarmento et al., 2014; Iván-Baragaño et al., 2023a; Nunes et al., 2022). In this analysis, the target or focal behavior was C1ADAPTRI (existence of technical and tactical adaptations based on the opponent), while the same behaviors were considered as conditioned. This focal behavior was selected because interviewees identified it as a key variable for success during matches and also because it has been used as a reference behavior in other research (e.g., Franchini et al., 2005).

Based on these data, a vector map was created to illustrate the relationships between the focal behavior and the conditioned behaviors. The length and angle of each vector (one for each conditioned behavior) were calculated.

Only behaviors with a radius equal to or greater than 1.96 were included.

All analyses were performed using the open-source software HOISAN (v 2.0) (Hernández-Mendo et al., 2012), except for the lag 0 calculation, which was conducted using the open-source software GSEQ5 (Bakeman & Quera, 2011).

The selected focal behavior was C1ADAPTRI (existence of technical and tactical adaptations by judokas based on the opponent), and all other behaviors were treated as conditioned behaviors.

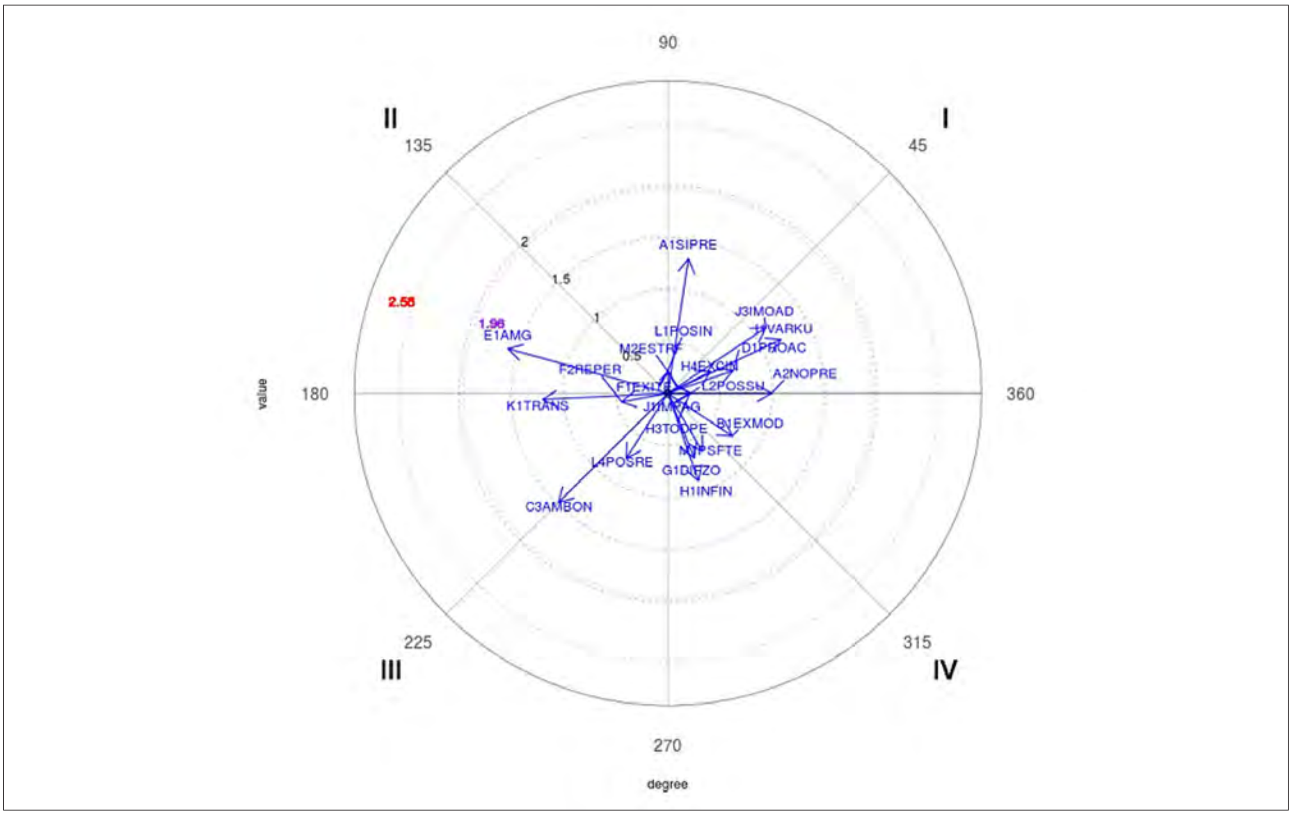
Results

The results of the polar coordinate analysis are presented below (Table 3, Figure 1). The vectors indicate the type of relationship between the focal behavior and each conditioned behavior, and vice versa, as well as the intensity of these relationships. Based on these values, a vector map was constructed showing the relationships between the focal behavior and the remaining conditioned behaviors.

Table 3
Relationship between the focal category (C1ADAPTRI/Existence of technical-tactical adaptations based on the opponent), and the rest of the categories

Category	Quadrant	Prospective p.	Retrospective p.	Ratio	Radius	Angle
A1SIPRETEC	I	0.2	1.29	0.99	1.31	81.34
A2NOPRETEC	I	–0.99	0	0	0.99	0
B1EXMOD	IV	0.62	–0.41	–0.55	0.74	326.31
C3AMBONIN	III	–1.05	–1.05	–0.71	1.48	225
D1PROAC	I	0.63	0.22	0.33	0.66	19.29
E1AMG	II	–1.53	0.43	0.27	1.59	164.32
F1EXITECTA	I	0	0.21	1	0.21	90
F2REPERT	III	–0.44	–0.08	–0.18	0.45	190.41
G1DIFZON	IV	0.25	–0.62	–0.93	0.67	292.09
H1INFINPER	IV	0.29	–0.84	–0.94	0.89	289.17
H3TODPER	I	0.21	0	0	0.21	0
H4EXCINPER	I	0.41	0.21	0.46	0.46	27.32
I1VARKUM	I	1.08	0.52	0.43	1.2	25.61
J1IMPAG	I	0.21	0	0	0.21	0
J3IMOADAP	I	0.93	0.63	0.56	1.13	34.01
K1TRANSPS	III	-1.19	–0.06	–0.05	1.2	182.79
L1POSIND	I	0	0.22	1	0.22	90
L2POSSUP	I	0.22	0	0	0.22	0
L4POSRECEJ	III	-0.4	–0.62	–0.84	0.74	237.37
M1PSFTECTAC	IV	0.33	–0.56	–0.86	0.65	300.63
M2ESTRFTT	I	0	0.21	1	0.21	90

Figure 1
Vector map showing the relationships between the focal category (C1ADAPT/Existance of technical-tactical adaptations based on the opponent) and the remaining categories of the indirect observation instrument



The results shown in Table 3 and Figure 1 indicate that in Quadrant I, where the focal behavior activates the paired behavior both prospectively and retrospectively (mutual activation), the following paired behaviors are located: A1SIPRETEC (existence of technical predominance in standing and groundwork judo situations depending on weight category, sex, and/or age), with a radius of 1.31 and an angle of 81.34°; A2NOPRETEC (absence of technical predominance in standing and groundwork judo situations depending on weight category, sex, and/or age), with a radius of 0.99 and an angle of 0°; D1PROAC (proactive intention of the judoka during the matches), with a radius of 0.66 and an angle of 19.29°; F1EXITECTA (use of successful technical-tactical behaviors in situations of scoreboard disadvantage and nearing the end of the match), with a radius of 0.21 and an angle of 90°; H3TODPER (all match time periods are crucial in a judo bout), with a radius of 0.21 and an angle of 0°; H4EXCINPER (all time periods except the initial one are crucial in a judo bout), with a radius of 0.46 and an angle of 27.32°; I1VARKUM (importance of *kumikata* and its variations), with a radius of 1.2 and an angle of 25.61°; J1IMPAG (imposition of *kumikata* in situations where the opponent hinders its execution), with a radius of 0.21 and an angle of 0°; J3IMOADAP (imposition or adaptation of *kumikata* based on the situation), with a radius of 1.13 and an angle of 34.01°; L1POSIND (groundwork performed from an individualized position and from the grip), with a radius of 0.22 and an angle of 90°; L2POSSUP (groundwork performed from a supine position), with a radius of 0.22 and an angle of 0°; M2ESTRFTT (strategic, physical, technical, and tactical requirements a judoka must meet to succeed), with a radius of 0.21 and an angle of 90°.

In Quadrant II, where the focal behavior inhibits the paired behavior prospectively and activates it retrospectively, the paired behavior E1AMG is found, with a radius of 1.59 and an angle of 164.32°. Based on the results, it is plausible to think that for judokas, the use of feints and deceptions during matches may serve as an effective strategy to create uncertainty about their actual technical-tactical intentions.

In Quadrant III, where the focal behavior inhibits the paired behavior both prospectively and retrospectively, the following behaviors are located: C3AMBONIN (depending on the situation, existence of technical-tactical adaptations or maladaptations by the judoka based on the opponent), with a radius of 1.48 and an angle of 225°; F2REPERT (use of a specific repertoire in situations of scoreboard disadvantage and nearing the end of the match), with a radius of 0.45 and an angle of 190.41°; K1TRANSPS (foot-to-ground transitions are essential during judo matches), with a radius of 1.2 and an angle of 182.79°; L4POSRECEJ (groundwork based on the position of the performer and the receiver), with a radius of 0.74 and an angle of 237.37°.

Finally, in Quadrant IV, where the focal behavior activates the presence of the paired behavior prospectively but not retrospectively, the following behaviors are found: B1EXMOD (presence of technical and tactical trends in current judo), with a radius of 0.74 and an angle of 326.31°; G1DIFZON (existence of multiple optimal working zones within the tatami), with a radius of 0.67 and an angle of 292.09°; H1INFINPER (initial and/or final time periods are crucial in a judo bout), with a radius of 0.89 and an angle of 289.17°; M1PSFTECTAC (psychological, physical, technical, and tactical requirements a judoka must meet to succeed).

Discussion

The present study was conducted with the aim of detecting regularities in the existence of technical and tactical adaptations based on the opponent, as well as performing an interrelational analysis of related behaviors, based on in-depth interviews with coaches, judokas, physical trainers, and judo instructors. In this regard, in the communicative pattern of the interviews conducted, various behaviors were found to be linked to the existence of technical and tactical adaptations by judokas based on the opponent. These communicative patterns were accurately identified thanks to the structured coding process typical of indirect observation, which made it possible to segment the discourse into textual units and analyze the frequencies, co-occurrence, and interaction of the different observed categories. This systematization not only facilitated the detection of regularities within the discourse but also strengthened the analysis of the relationships between technical-tactical dimensions.

As for the vector size and its angle, these determine the intensity of the relationships between the focal behavior and the paired behaviors. From an applied perspective, Quadrant I reflects the importance of studying opponents and adjusting the behavioral scheme. Interviewee 1 stated: “I had a technical-tactical scheme for right- and left-handed opponents, and I studied my rivals” (A1SIPRETEC). Interviewee 5 emphasized that in high-level competition not all matches are won the same way: “You must know who you have in front of you and when to be proactive or cautious” (A1SIPRETEC). He also stressed the need to make strategic adaptations without abandoning one’s own style. Regarding technical-tactical predominance by weight, sex, or age, several interviewees agreed on its influence, albeit with exceptions. For example, Interviewee 4 (female) noted differences by weight and age, while Interviewee 5 (male) pointed out that female and male judo are sometimes similar.

On the relationship between technical-tactical behaviors and specific situations, Interviewee 2 (male) said: “I always ask: what is the opponent doing? And we adjust the match accordingly." When at a disadvantage, he would opt for previously successful tactics, avoiding unfavorable ones (A1SIPRETEC). He also highlighted the relevance of all time periods of the match, especially the first, for exploration, and the fourth, where fatigue affects performance (H3TODPER).

Regarding *kumikata*, several interviewees agreed on the importance of mastering it to execute effective techniques. For instance, Interviewee 4 (female) considered it essential to impose the grip (J1IMPAG), while Interviewee 2 (male) noted that dominating the grip facilitates controlling the match (J1IMPAG). In groundwork situations, Interviewee 2 (male) suggested acting from comfortable and individualized positions, while Interviewee 3 (female) preferred working from positions that allowed for both defense and attack (J3IMOADAP).

In Quadrant II, the use of feints and deceptions (E1AMG) was highlighted. Interviewee 2 (male) considered that they must generate real threat to the opponent, while others viewed them as effective tools to provoke reactions. Interviewee 8 (male) noted that the higher the level of deception, the lower the possibility that the opponent will decipher it.

Quadrant III underlined the need to train transitions between standing and groundwork (K1TRANSPS). Interviewee 1 (female) observed that insecurity in groundwork conditions performance in standing judo (L4POSRECEJ). Interviewee 5 (male) stated that matches are often won through an effective transition to groundwork (K1TRANSPS), such as immobilizations or strangles. Interviewee 6 (male) stressed the importance of chaining techniques in groundwork and adapting positions to maximize effectiveness (L4POSRECEJ).

In Quadrant IV, the influence of technical role models and fashions imposed by rule changes (B1EXMOD) was mentioned. Interviewee 5 (male) stressed the importance of working in specific areas of the tatami to avoid penalties or loss of balance (G1DIFZON). Regarding activation, interviewees considered the opening and closing minutes of the match to be key, with the latter being the most critical due to accumulated fatigue (H1INFINPER).

Conclusions

The main conclusions of this study can be summarized in two:

1) The variability in the responses reflects the diverse experiences and roles of the interviewees—judokas, strength and conditioning coaches, judo instructors in the Bachelor's Degree in Physical Activity and Sports Sciences, and coaches—which provides unique perspectives.
2) The analysis showed that adaptive behaviors and knowledge of the opponent are essential for success. Patterns vary according to context and highlight the strategic use of feints, the importance of mastering transitions and areas of the tatami, and the influence of technical role models.

Limitations

Among the main limitations of the study is the dependence on the original communicative context, since the data analyzed were not generated under conditions controlled by the researcher. This may hinder the full interpretation of the content due to the lack of all contextual information. Furthermore, this type of observation entails a greater risk of cognitive interference during the segmentation and coding of textual units, which may introduce some degree of subjectivity despite the control mechanisms applied.

Future Lines of Research

In the near future, judo researchers could propose studies aimed at understanding the influence of the dimensions suggested in this study on success in amateur, grassroots, and elite women's and men's judo. In this regard, studying aspects such as: (i) the existence of technical predominance in standing and groundwork judo situations according to weight category, sex, and/or age; (ii) the existence of tactical predominance in standing and groundwork judo situations according to weight category, sex, and/or age; (iii) the existence of optimal working areas within the tatami; or (iv) the existence of possible psychological, physical, technical/tactical profiles that a judoka must have to achieve success, will help expand the scientific corpus on this subject while simultaneously increasing the potential performance of competitors.

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SPORT TRAINING

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Relationship Between Possession Initiation Type and Offensive Effectiveness in UEFA Euro 2020 Football: An Observational Study

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Aerial view of a paragliding flight over autumn foliage.
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Abstract

Although research in high-performance football has extensively addressed the offensive phase, specific analysis on the relationship between initiation of possession and offensive effectiveness remains limited. Within the framework of observational methodology, 2,324 offensive sequences in elite football were recorded and analyzed. Three objectives were established for the present study: at the univariate level, to describe the most common patterns in ball recovery and possession initiation; at the bivariate level, to identify statistically significant relationships between the type of recovery and the other variables considered; and at the multivariate level, to develop a classification model that explains the interaction between key dimensions. The results showed that ball recovery through transition occurs in 58% of cases, mainly in the team's own field (61.5%), and that teams tend to progress quickly (81%) after regaining possession. The bivariate analysis confirmed that recoveries in transition favor direct attacks, and that recoveries after set pieces allow for a better defensive organization of the opponent. The duration of possession is shorter when the recovery is in transition compared to recoveries after set pieces. The decision tree model reinforced these findings and highlighted the influence of the type of recovery through transition. In conclusion, these findings may have direct application in high-performance football, providing key information to optimize offensive tactics and maximize the likelihood of success.

Keywords: attack, high performance, observational methodology, offensive process

Introduction

Football research has experienced a huge growth in recent years. According to the *PubMed* database, and entering the topics "soccer" and "football", 2,450 scientific studies have been published in the decade 2015-2025 alone. This figure reflects the strong expansion of research into the sport from different areas such as physiology, psychology and tactics (Rein & Memmert, 2016; Goes et al., 2021).

In relation to the latter, and more specifically to the offensive process, this has been the subject of considerable attention in the scientific literature in recent years (Baert & Amez, 2018; Fernández-Navarro et al., 2018; Kempe & Memmert, 2018; Wilson et al., 2020; Mitrotasios et al., 2019; Sarmento et al., 2018). These studies have provided advanced analytical tools that facilitate the identification of tactics from the build-up phase through to the completion of attacking plays.

Within this framework, several studies have examined the key factors influencing offensive play. One of the most studied aspects is ball possession, which is considered a key indicator of attacking dynamics (Jones et al., 2004; Lago-Peñas & Martín-Acero, 2007). The contexts of interaction (Castellano et al., 2013) are also key aspects.

In terms of offensive playing styles, studies such as those by Hewitt et al. (2016) and Lago-Peñas et al. (2017) have analyzed the effectiveness of different attacking strategies, including counter-attacking, direct attack and combination attack in the context of high-performance football. Complementarily, the generation of goal opportunities and associated behavioral patterns has been extensively analyzed in the literature (Amatria et al., 2019; Tenga et al., 2010; Wright et al., 2011).

While these studies have increased our understanding of offensive mechanisms in football, there are still unresolved questions. A critical aspect is how possession is regained to initiate an attack. Previous research has analyzed the location of recovery (Barreira et al., 2014a), the specific zones of the field where it occurs (Barreira et al., 2014b; Espada et al., 2018) and the defensive systems employed for this purpose (Toda et al., 2022). However, there is little research (Iván-Baragaño et al., 2021) that has addressed the comparison between different methods of recovery, such as direct ball stealing (change between possession and non-possession roles) versus set pieces resulting from rule infringements (e.g. throw-ins, fouls, and restarts following a shot on goal, among others). This question still represents a gap in the scientific literature.

Therefore, the aim of the present study was threefold: at a univariate level, to characterize and describe the usual practices of attacking mechanisms in football according to different dimensions of interest; at a bivariate level, accompanied by a chi-squared contrast, to find out the possible statistically significant relationships between the dimensions considered and the way of recovering the ball; finally, at a multivariate level, to develop a classification model to explore the interaction between dimensions associated with the type of initiation of ball possessions.

Method

For the development of this work, the observational methodology (Anguera, 1979) was used, which has proven to be one of the most appropriate for the study of spontaneous interaction behavior among athletes, also from its mixed methods aspect (Anguera et al., 2014; Anguera & Hernández-Mendo, 2016).

Design

The design of this research was nomothetic, as a plurality of units were analyzed; in terms of temporality, a cross-sectional design was chosen, as a specific competition was analyzed; and finally, multidimensional, due to the multiple levels of response (Anguera et al., 2011). It is worth noting that the observation process adhered to scientific rigor criteria, with complete observer awareness.

Participants

A purposive observational or convenience sampling method was used to select participants (Anguera et al., 2011). Ball possessions were collected and analyzed during the final phase of the UEFA EURO 2020 tournament. In total, 2,324 attacks were examined, corresponding to the round of 16, the quarter-finals, the semi-finals, and the final. The inclusion criteria were as follows: the offensive action was recorded from the moment possession changed from one team to the other or a regulation stoppage occurred. In addition, it was considered possession when any of the following conditions were met: a duration of possession equal to or longer than 4 seconds; when the player recovered the ball and made a pass; when the player made three consecutive touches on the ball without passing, provided the possession lasted 4 seconds or more, or when a shot was taken. The data collection was carried out through public images broadcast on television (Mediaset channel), a general-interest broadcaster sponsored by various private entities.

Observational Instrument

The observational instrument proposed by Maneiro et al. (2020) was used for this study (see Table 1), due to its good fit when analyzing the offensive phase in football (Maneiro et al., 2023).

In addition, the instrument contributes to the satisfaction of the pre-set objectives. The observational instrument is a combination of field format and category systems (Anguera et al., 2007). Dimensions and subdimensions collated in previous work have been included, such as the following: context of interaction (Castellano, 2008), intention (Maneiro et al., 2019), partial result (Lago, 2009), period of the game (Jones et al., 2004).

Table 1
Observation instrument

Dimension	Subdimension
Match period	First half Second half Extra time
Initiation type	Transition Set piece
Context of interaction	AD: advanced line vs. deep line AM: advanced line vs. midfield line AA: advanced line vs. advanced line MM: midfield line vs. midfield line MD: midfield line vs. deep line MA: midfield line vs. advanced line DA: deep line vs. advanced line DM: deep line vs. midfield line GA: goalkeeper vs. advanced line AG: advanced line vs. goalkeeper
Intention	Progress Retain possession
OwF (time of possession in own field)	–10” 11-20” 21-30” 31-40” +41”
OpF (time of possession in opponent’s field)	–10” 11-20” 21-30” 31-40” +41”
FZ	Own field Opponent’s field
Total time of possession	–10” 11-20” 21-30” 30-40” +41”
Passes	0-7 8-15 +15
Success of the action	Goal Shot Ball into the box Unsuccessful
Partial result	Winning Drawing Losing
Final result	Win Loss

Source: Maneiro et al. (2020)

Registration and Coding

Data Quality

Data recording (Hernández-Mendo et al., 2014), as well as the concordance analysis, was carried out using Lince Plus software (Soto et al., 2019). Four observers were selected for data collection, all of whom held PhDs in Sports Sciences and were UEFA PRO licensed coaches. The inter-observer agreement analysis was performed on a pairwise basis. The six possible combinations between the four observers (Ob1-Ob2, Ob1-Ob3, Ob1-Ob4, Ob2-Ob3, Ob2-Ob4 and Ob3-Ob4) were carried out, and an average Kappa value of .92 was obtained, which according to the scale by Fleiss et al. (2003) can be considered very good.

Prior to the coding process, eight training sessions were carried out, following Anguera et al. (1999). The training sessions lasted 2 hours each. The first three sessions were conducted as a group with the selected observers. The study was presented to them theoretically, the behaviors to be observed in players were defined, the observational instrument was presented to them, and they were trained in the use of the Lince Plus recording tool. The fourth session involved the observers in the observation and recording of 20 offensive actions previously selected by the principal investigator, ordered from least to most complex. After recording the actions, the discrepancies found were discussed. The fifth and sixth sessions were conducted individually with each observer. The recorded actions were initially outlined by the lead researcher, and the observers were trained on how to record the actions. The last two training sessions were also conducted individually and Cohen's Kappa coefficient of concordance between the principal investigator and each observer was checked. Ten percent of the total sample (n = 233) was used to measure data quality.

The data obtained were Type IV, that is, time-based concurrent data (Bakeman, 1978). This is due to the fact that there are co-occurrences of players' behaviors.

Statistical Analysis

SPSS Statistics 25 was used to carry out the analyses. Firstly, in order to characterize and describe the usual practices of the offensive process, a univariate or descriptive analysis was conducted. Next, in order to identify possible statistically significant relationships between the dimensions considered and the type of ball recovery, a bivariate analysis was conducted using a chi-square test. Finally, a multivariate analysis was carried out, based on the decision tree technique (Rokach & Maimon, 2005), with the aim of developing a classification model that allows us to understand the interaction of the dimensions associated with the initiation of ball possessions.

Results

In the total number of matches belonging to the round of 16, quarter-finals, semi-finals and final, a total of 2,324 attacks were carried out, which is an average of 72 attacks per team/match (Table 2). The low level of attacking success (goal, shot or delivery into the box) stands out, as only 2% of possessions ended in a goal, 12% in a shot, 21% in a delivery into the box and 65% ended unsuccessfully. It is also noteworthy that the teams took possession in their own field (61.5%), that they made fewer than 7 passes, and that they had the will to attack (81.4%).

Table 2
Results at descriptive level

Dimension	Subdimension	Percentage	Frequency
Match period	First half	44.8%	1041
	Second half	44.8%	1041
	Extra time	10.4%	242
Initiation type	Transition	57.9%	1346
	Set piece	42.1%	978
Intention	Progress	81.4%	1892
	Retain possession	18.6%	432
OwF (time of possession in own field or defensive zone)	–10''	55.6%	1291
	11-20''	23.2%	539
	21-30''	11.7%	273
	31-40''	8.7%	203
	+41''	0.8%	18

Table 2 *(Continuation)*
Results at descriptive level

Dimension	Subdimension	Percentage	Frequency
OpF (time of possession in the opponent's field or offensive zone)	–10''	73.5%	1707
	11-20''	16.3%	379
	21-30''	6.4%	148
	31-40''	2.0%	46
	+41''	1.9%	44
Total time of possession	–10''	29.6%	688
	11-20''	32%	743
	21-30''	18.1%	421
	31-40''	10.2%	236
	+41''	10.2%	236
Zone	Own field	61.5%	1430
	Opponent's field	38.5%	894
Passes	0-7	72.2%	1978
	8-15	23.5%	545
	+15	4.3%	101
Context of interaction	AD	21.4%	498
	AM	1.1%	25
	AA	1.6%	37
	MM	37.0%	861
	MD	0.8%	18
	MA	5.5%	128
	DA	23.8%	553
	DM	1.0%	24
	GA	7.6%	176
	AG	0.2%	4
Partial result	Winning	14.0%	325
	Drawing	64.1%	1490
	Losing	21.9%	509
Success of the action	Goal	2.0%	47
	Shot	12.1%	281
	Ball into the box	20.9%	485
	Unsuccessful	65.0%	1511
Final result	Win	46.2%	1073
	Loss	53.8%	1251

Results of the Bivariate Chi-Squared Test

In order to find out the relationship between the dimension "initiation type" and the other dimensions considered, a contingency table with a chi-squared test was used to compare the degree of effectiveness achieved according to the different dimensions included in the observation instrument. (Table 3)

Table 3
Results at the bivariate level, using the "initiation type" dimension as the reference

Dimension	Subdimension	Transition	Set piece	χ^2	Sig.	Contingency ratio
Match period	FH First half	602.9 (59.9%)	438.1 (40.1%)	3.33	.18	---
	SH Second half	602.9 (56%)	438.1 (44%)			
	ET Extra time	140.2 (57.4%)	101.8 (42.6%)			
Intention	P Progress	1095 (60.1%)	796.2 (39.9%)	20.2	< .001	.09
	RP Retain Possession	250.2 (48.1%)	181.8 (51.9%)			
Zone	D Defensive	828.2 (64.3%)	601.8 (35.7%)	61.4	< .001	.16
	O Offensive	517.8 (47.8%)	376.2 (52.2%)			
OwF (time of possession in own field or defensive zone)	–10''	988.6 (59.9%)	718.4 (40.1%)	17.5	.002	.08
	11-20''	219.5 (55.4%)	159.5 (44.6%)			
	21-30''	85.7 (48.6%)	62.3 (51.4%)			
	31-40''	26.6 (37%)	19.4 (63%)			
	+41''	25.5 (54.5%)	18.5 (45.5%)			
OpF (time of possession in the opponent's field or offensive zone)	–10''	747.7 (54.8%)	543.3 (45.2%)	13.8	.008	.07
	11-20''	312.2 (62.2%)	226.8 (37.8%)			
	21-30''	158.1 (59.3%)	114.9 (40.7%)			
	31-40''	117.6 (65%)	85.4 (35%)			
	+41''	10.4 (50%)	7.6 (50%)			
Time of possession	–10''	398.5 (56%)	289.5 (44%)	2.06	.72	---
	11-20''	430.3 (59.6%)	312.7 (40.4%)			
	21-30''	243.8 (58.2%)	177.2 (41.8%)			
	31-40''	136.7 (57.2%)	99.3 (42.8%)			
	+41''	136.7 (58.5%)	99.3 (41.5%)			
Passes	0-7	971.9 (58.9%)	706.1 (41.1%)	2.81	.24	---
	8-15	315.6 (54.9%)	229.4 (45.1%)			
	+16	58.5 (57.4%)	42.5 (42.6%)			
Context of interaction	AD	288.4 (49.2%)	209.6 (50.8%)	209.7	< .001	.300
	AM	14.5 (68%)	10.5 (32%)			
	AA	21.4 (0%)	15.6 (100%)			
	MM	498.7 (59.2%)	362.3 (40.8%)			
	MD	10.4 (50%)	7.6 (50%)			
	MA	74.1 (30.5%)	53.9 (69.5%)			
	DA	320.3 (77.4%)	232.7 (22.6%)			
	DM	13.9 (66.7%)	10.1 (33.3%)			
	GA	101.9 (46.6%)	74.1 (53.4%)			
	AG	2.3 (0%)	1.7 (100%)			
Outcome of the play	G Goal	27.2 (44.7%)	19.8 (55.3%)	25.3	< .001	.104
	S Shot	162.7 (56.9%)	118.3 (43.1%)			
	BB Ball into the box	280.9 (49.3%)	204.1 (50.7%)			
	U Unsuccessful	875.1 (61.3%)	635.9 (38.7%)			
Partial result	W Winning	188.2 (67.7%)	136.8 (32.3%)	18.2	< .001	.08
	D Drawing	863.0 (57.5%)	627.0 (42.5%)			
	L Losing	294.8 (52.8%)	214.2 (47.2%)			
Final result	W Win	621.5 (59.4%)	451.5 (40.6%)	1.71	0.19	---
	L Loss	724.5 (56.7%)	526.5 (43.3%)			

Results of the Decision Tree Analysis

The results of the decision tree based on the CHAID algorithm are presented in Figure 1. This model comprised 13 nodes, of which 8 were terminal. The theoretical results of the model are presented in Table 4.

To carry out the validation process, the total sample of possessions (2,324) was divided into a training set (70%) and a test set (30%).

The model's predictive dimensions are shown in Table 5, titled Classification of the Model. In this way, the evaluation of the effectiveness of the model's performance can be observed. The results in Table 5 indicate that the model correctly classified 64.5% of the sample. Specifically, for each subdimension of the dependent variable, the highest accuracy was found in the "transition" category, at 87.1% (with a specificity of 87.1% and a sensitivity of 40.1%).

The model shows a predictive risk of .326 (32.6%) in the training set, with a standard error of 0.012. In the contrast (validation) phase, the risk increases slightly to .355 (35.5%), with a standard error of 0.019. This indicates that the model has a moderate error rate, with acceptable performance in both training and validation. Although there is a slight increase in error during the test phase, it appears to be relatively stable, indicating that the model generalizes well without excessive overfitting.

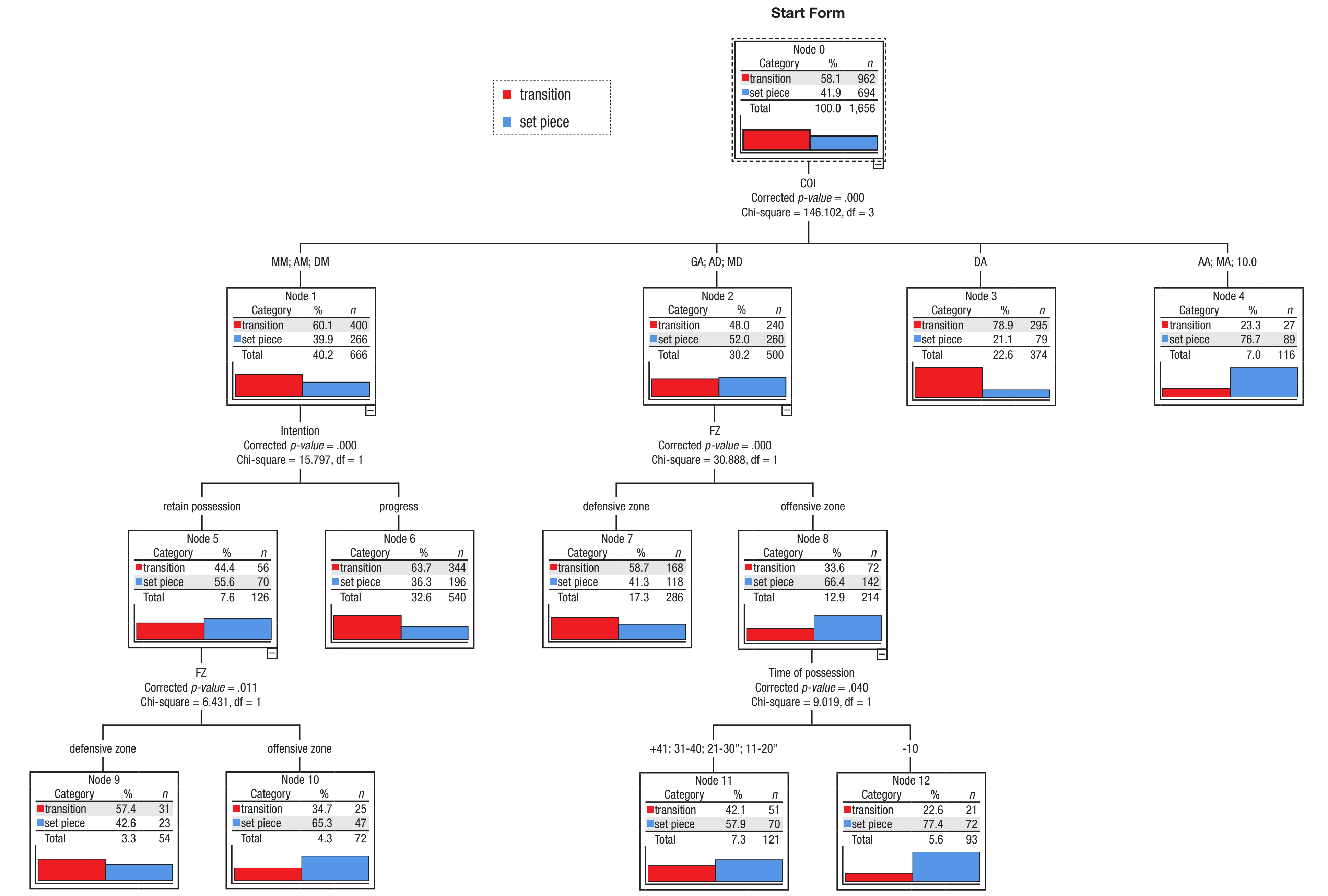
Table 4
Summary of the model presented

Summary of the model		
Specifications	Growth method	CHAID
	Dependent dimension	StartForm
	Independent dimensions	Match period. COI. Intention. OwH. OpH. FZ. Time of possession. Passes. Outcome of the play. Partial result. Final result
	Validation	Sample division
	Maximum depth	3
	Minimum cases per node	100
	Minimum cases in the child node	50
Results	Dependent dimensions included	COI. Intention. FZ. Time of possession
	Number of nodes	13
	Number of terminal nodes	8
	Depth	3

Table 5
Classification of the model

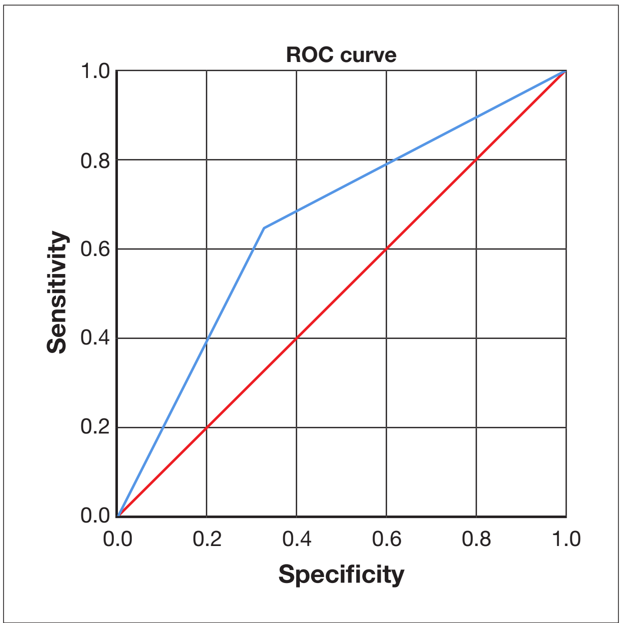
Classification				
Sample	Observed	Prediction		
		Transition	Set piece	Correct percentage
Training	Transition	838	124	87.1%
	Set piece	416	278	40.1%
	Total percentage	75.7%	24.3%	67.4%
Contrast	Transition	330	54	85.9%
	Set piece	183	101	35.6%
	Total percentage	76.8%	23.2%	64.5%

Figure 1
Decision tree model



Finally, the performance of the model was assessed using the Area Under the ROC Curve (AUC) (Figure 2). The ROC curve is a graphical representation that evaluates the performance of a binary classification model by showing the relationship between the true positive rate (sensitivity) and the false positive rate (1 - specificity) across different decision thresholds. Its main metric is the AUC (Area Under the Curve), which indicates the model's ability to distinguish between classes. In this case, it yielded a value of .66, meaning the model has a 66% chance of correctly ranking a positive case above a negative one. This suggests a good performance—better than random (.50)—but still far from optimal (1).

Figure 2
ROC curve



Discussion

This study had three main aims: at the univariate level, to describe the most common patterns of the offensive process; at a bivariate level, to determine the possible statistically significant relationships between the dimensions considered and the type of ball recovery; and finally, at a multivariate level, to develop a classification model to determine the interaction of the dimensions associated with the initiation of ball possessions.

At the univariate level, it was observed that teams recovered the ball through transition in 58% of the cases, mainly in their own field (61.5%), with the score tied (64%), and in the midfield line of the observed team against the midfield line of the opponent (37%). Furthermore, the initial intention of the team that recovers the ball was to progress forward 81% of the time. These results represent a first approximation to the characterization of this type of actions and coincide with previous research, such as the study by Oberstone (2011), which highlights a higher frequency of recoveries in transition. They are also in line with the findings of Tenga and Sigmundstad (2011) regarding the prevalence of own-field recoveries and with the work of Barreira et al. (2014a) on behaviors following ball recovery.

At the bivariate level, we proceeded to analyze the relationship between the dimension "initiation type" and the other dimensions included in the observation instrument. The results reveal interesting relationships. Firstly, when they regain the ball through transition, the tactical behavior of the teams is to progress and advance towards the opponent's goal, a fact that is in line with that proposed by Barreira et al. (2014b) and Casal et al. (2019). These authors found that the behavior of progressing is directly associated with successful teams or those leading on the scoreboard, although other authors relate it to playing style (Lago-Peñas & Dellal, 2010).

As far as the time of possession is concerned, the results are conclusive and directly related to the previous paragraph: the ball possessions of teams that recover the ball through a steal in the opponent's field are significantly shorter than those of teams that recover the ball by set pieces. At this point, it is very likely that offensive transitions (Eusebio et al., 2025), and direct attack or counter-attack (Lago-Peñas et al., 2017) will become relevant. When the ball is recovered from a set piece (throw-in, free kick...), the opposing team has time to strategically retreat. In contrast, when possession is regained through transition, numerous spaces emerge that the recovering team can exploit to progress.

Interesting results are also found in the ball recovery zone. While teams that recover the ball through a steal tend to do so in their own field or defensive zone, those that recover it through a set piece typically do so in the offensive zone. In the first case, the defensive density of the team out of possession favors recovery through transition or a steal, whereas recovery in the offensive sector via set pieces may stem from pressing actions by the defending team, which hasten the opponent's decision-making and can thus lead to more turnovers. More specifically, the throw-in appears to be the set piece action that gains the most relevance, according to Barreira et al. (2014a), who found that the best teams tend to win the ball back in this way, following pressure actions and harassment of the opponent, inducing errors (Vogelbeinet al., 2014).

When analyzing which line recovers the ball against which opposing line based on the interaction context, it is observed that the defensive line tends to recover the ball through steals against the opponent's advanced and midfield lines. On the other hand, when the midfield line is the one recovering the ball, it typically does so through set-piece actions. One possible explanation is that defenders possess more specialized technical and tactical skills for executing steals, supported by defensive structures specifically trained for this purpose. In contrast, the midfield line has a more versatile profile, capable of balancing offensive and defensive roles and adapting its resources to the demands of the game and the characteristics of the opponent.

In this context, the study by Castellano et al. (2013) analyzed the use of space in football and highlighted the importance of spatial relationships among players of both teams. The authors noted that opportunities for action arise from the complementarity of relationships between players, implying that the positioning and spatial interactions between defensive and attacking lines are fundamental to understanding ball recovery dynamics.

In addition, previous research has found that recovering the ball in midfield zones increases attacking efficiency. For example, Barreira et al. (2014b) found that interceptions in the central midfield-offensive zone resulted in ineffective attacks, while goalkeeper interventions in the central defensive zone did not show significant relationships with end-of-attack inducing behaviors.

The behavior of the partial score depending on how the ball is recovered is also particularly noteworthy. Teams that are winning recover the ball twice as often through a steal than through a set-piece situation. Fernandes et al. (2020) claim that worse teams are less likely to recover the ball through a steal or interception. In contrast, Barrreira et al. (2014b) state that attacking patterns are directly influenced by the way in which the ball is recovered. Therefore, it is possible to think that, in order to optimize the attack once the ball has been recovered and to take advantage of the moments of disorder of the opposing team to adjust to the role change (from ball possessor to non-possessor), teams that are winning opt to recover the ball in transition.

Finally, at the multivariate level, the decision tree model reinforces the previous results, and highlights which lines of interaction initiate ball possession. Once again, the dimension that provides the greatest information gain is the interaction context, confirming that the more defensive or deeper the recovering line is (defensive or midfield line), the more likely it is to regain possession through a steal during transition. In contrast, the more advanced the line (advanced line), the more likely it is to recover the ball through a set-piece situation. Moreover, when ball recovery occurs through a steal, teams tend to progress immediately into attack, aiming to capitalize on the role transition moment to maximize their chances of offensive success. In other words, it can be concluded that recovering the ball through a transitional steal fosters or increases offensive opportunities to advance into the opposition half.

Conclusions

The present study aimed to explore in depth the relationship between the type of possession initiation and its offensive effectiveness. For this purpose, the "initiation type" dimension was used as a reference point. The main conclusions of the present study can be summarized in four points: 1) At the univariate level, teams that recover the ball through a transition tend to advance quickly into attack compared to when they regain possession through a set piece; 2) At the bivariate level, fast attacks following a steal are associated with shorter possessions and opportunities for direct play or counterattacks, whereas recoveries through set pieces favor a more elaborate build-up; 3) At the multivariate level, ball recovery in defensive zones occurs mostly through transitions, while in offensive zones it is more frequently associated with set-piece situations; defensive and midfield lines are more likely to recover the ball in transition, whereas advanced lines tend to do so through set pieces.

Practical Applications

Based on the conclusions of the present study, several practical applications can be drawn for coaches at youth, amateur, and elite levels of football: encouraging specific training sessions to take advantage of offensive transitions after ball recovery, such as drills focused on decision-making at speed and rapid finishing; and developing strategies to maximize pressing and force turnovers from the opponent, while optimizing the execution of set-piece actions. In addition, from the perspective of opponent analysis, it is advisable to identify the opposing team's ball recovery patterns in order to design effective pressing and recovery strategies.

Limitations

Some of the possible limitations of the present study include: the degree to which the results can be generalized, as they refer to a single specific tournament; the extrapolation to women's football, since the study focuses solely on men's football; and, finally, the influence of other dimensions or subdimensions not considered, which may affect the type of possession initiation.

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