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Bodily Timelessness

Farewell Editorial by the Chief Editor

Marta Castañer Balcells¹  

¹ National Institute of Physical Education of Catalonia (INEFC), University of Lérida (UdL). Lérida (Spain).



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Short track athlete in
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In this brief essay on corporeality, I offer a “counterpoint” as I bid farewell as editor-in-chief of *Apunts*. I witnessed the birth of the journal when I was a student at INEFC Barcelona, and over the past seven years, I have had the honor of directing it with the extraordinary publications team at INEFC, and bringing it to the top tier of scientific journals, indexed as Q1 by Scopus and in JCR and Q2 by WoS.

My professional career at INEFC has spanned four decades devoted to our profession, at a time when almost everything still had to be done. From the very beginning, we had to envision the future and with this short essay, my intention is not to close a chapter, but rather to revisit and reflect upon all that I have carefully and diligently cultivated through the Chair of Motor Skills¹, research projects, and my direction of the scientific journal *Apunts Educación Física y Deportes*.

Therefore, I am not presenting a conventional scientific article, like so many others I have supervised for the journal, but rather a concise and modest essay on the essence and fundamental substance of our profession, which I believe should always remain at the forefront: the body.

Bodily Timelessness

It is ideas about the body that evolve historically; yet the body itself, while absorbing the symbolic constructions of each historical period, remains, in a sense, timeless.

The body can be understood as a silent substance, to which props and recurring attributes are assigned along the chronological frieze of history. In this way, through our bodies, we act as conveyors of space and time, and consequently, of the perspectives of each historical moment. The body is what is visible; movement disappears, and since the various bodily manifestations are generated through the body's movement, we might say that it is ephemeral. Bodily expression, therefore, is an ephemeral art.

A painting exists in a single dimension: that of space, even though it may evoke the historical time in which it was created. Choreographing, in the broad sense of the Latin term *choros*, involves depicting the dynamics of bodies as if in a continuously moving painting encompassing spacetime. Each motor action, each gesture, replaces the one that preceded it, which is why it is impossible for it to be permanently imprinted on the viewer's retina.

Only technological capture, such as current body motion capture systems, allows us to visualize, retrospectively, the "choreography" of our bodies—this time as if it were a painting in motion. It provides an optimal way to render bodily expression permanent. It is stimulating to consider how this capacity to move forward and backward in time enables us to begin intuitively grasping the concept of a timeless bodily language.

Similarly to contemporary hypertext, the narrative of the body can move beyond linearity and adopt multiple readings. The body, like so many other phenomena today, has entered the postmodern vision of multiplicity; consequently, the notion of contemporaneity—of accompanying each historical moment—begins to lose its force.

Thus, I consider that a perspective opens onto the concept of bodily timelessness; at the same time, however, I believe it should not be understood as a mere process of juxtapositions, but rather as dynamic processes of hybridization that allow for optimal interweavings toward new motor and sports manifestations.

The timelessness of bodily language is made possible through audiovisual technological supports that allow it to be "retained," thereby enabling the recovery of the image of a person, a smile, a glance, or a motor or sports action. Yet the timelessness of bodily language can also be sustained

through the collective unconscious, formed by the subjective traits that each "viewer" recreates and remembers in their mind. In this way, a cultural transmission chain is generated, which, when set in motion, allows the recovery of past bodily configurations—understanding that even the previous minute is, in itself, part of the past.

An accordion impresses us with its wide range in relation to its extensibility and sound registers. Its folds and sounds seem endless. Drawing an analogy between this idea and bodily language, we can come to understand that the backdrop of our motor and sports practices lies in our continuous gestural flow.

The deployment of multiple perspectives is what bodily languages provoke in any communicative or interactive situation between people. Gestural actions of the body are replicated and, in turn, multiplied. Altogether, this forms a composition that presents a new bodily discourse, highly dynamic, which fosters new questions and reflections in each generation.

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Physical Exercise as an Adjunctive Treatment in Eating Disorders: A Systematic Review

Clara Teixidor-Batlle^{1,2,3} , Eva Parrado^{4,5*}  & Carles Ventura¹ 

¹ Social and Educational Research Group on Physical Activity and Sport (GISEAFE), National Institute of Physical Education of Catalonia (INEFC), University of Barcelona (UB), Barcelona (Spain).

² Center for Studies in Sport and Physical Activity (CEEAF), University of Vic–Central University of Catalonia, Vic (Spain).

³ Research Group on Sport, Exercise and Human Movement (SEaHM), University of Vic–Central University of Catalonia, Vic (Spain).

⁴ Autonomous University of Barcelona (UAB), (Spain).

⁵ Sport Research Institute (IRE), Autonomous University of Barcelona (UAB), Bellaterra (Spain).

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Abstract

This systematic review aimed to identify the interventions carried out to date to assess the effectiveness of physical exercise (PE) as an adjunctive treatment for eating disorders (EDs). The main objectives of this systematic review were: (a) to identify which aspects—both symptomatological and physical—improve with the inclusion of PE in the treatment of EDs, and (b) to determine the characteristics that PE should have to improve the identified symptomatology. A literature search was conducted following PRISMA guidelines using the PubMed, Web of Science, PsycINFO, and Scopus databases. Keywords were divided into three groups (Eating disorders; Exercise and treatment; Characteristics of physical activity), and articles published between 2012 and 2022 were reviewed. Of the initial 1,247 results, 20 studies were included in the analysis, 10 of which were randomized controlled trials (RCTs). Improvements were observed in muscle strength, aerobic capacity, BMI, bone density, as well as in ED symptomatology and quality of life. However, due to methodological differences among the exercise programs, it was not possible to determine the specific characteristics responsible for symptom improvement. Further research is needed to determine the frequency, intensity, duration, type, and volume of PE programs.

Keywords: anorexia, bulimia, exercise treatment, intervention, physical activity

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*Corresponding author:

Eva Parrado
eva.parrado@uab.cat

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Short track athlete in
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Introduction

It has been demonstrated that engaging in physical activity (PA) promotes the physical, psychological, and social well-being of participants (González-Peris et al., 2022). In recent years, scientific literature has increasingly focused on the therapeutic properties of physical exercise (PE) in addressing mental health issues. Eating disorders (ED), such as anorexia nervosa (AN), bulimia nervosa (BN), binge eating disorder (BED), or other specified feeding or eating disorders (OSFED), are considered psychiatric conditions characterized by altered eating behaviors that impair health and psychosocial functioning (González-Peris et al., 2022). In several manifestations of these ED, patients use PA as a common strategy to lose weight, improve their figure (Quiles et al., 2021), compensate for or eliminate food intake, or to relieve negative states (anxiety, depression, and stress) and ED symptoms (concern about weight, drive for thinness, body dissatisfaction, and restrictive profiles). However, it has been shown that PE as an adjunctive treatment can have positive effects on the main symptoms of AN, on both physical and mental health, and can promote better engagement with healthcare teams (Quiles et al., 2021). In fact, the first studies on this topic, conducted by Blinder et al. (1970) and Beaumont et al. (1994), observed improvements in symptomatology after implementing a supervised PE program in groups of patients with EDs. Later research indicated that PE reduced compensatory behaviors and facilitated weight gain in anorexia, decreased drive for thinness, bulimic symptoms, and body dissatisfaction, increased strength levels, reversed cardiac abnormalities in severe anorexia, and improved quality of life (Calogero & Pedrotty, 2004; Cook et al., 2017; Fernández-del-Valle et al., 2014).

Interestingly, PE is still rarely used in mental health units as part of ED treatment due to concerns that it might reinforce excessive exercise aimed at achieving the "ideal body" (Quesnel et al., 2018). This is likely due to the absence of clear guidelines on how to manage PE in this context, the lack of standardized protocols guiding professionals on how to use exercise effectively as part of ED treatment, and differing attitudes toward these approaches in clinical settings (Fernández-del-Valle et al., 2014; Toutain et al., 2022).

Based on the above, the objectives of this systematic review were: (i) to identify which aspects, both symptom-related and physical fitness-related, improve with the inclusion of PE in the treatment of EDs, and (ii) to determine the characteristics that PE should have in treatment to improve the identified symptomatology.

Method

A systematic review of relevant literature was conducted following the PRISMA 2020 statement (Page et al., 2021). Due to the methodological and statistical heterogeneity of the included studies, a descriptive approach was adopted in the synthesis of the study (Rethlefsen et al., 2021).

Search Strategy

A search of the relevant literature was conducted in four databases: PubMed, Web of Science, PsycINFO, and Scopus. The search strategy included both controlled vocabulary terms and free-text terms (see Table 1).

Inclusion and Exclusion Criteria

For inclusion, the retrieved articles had to have been published between 2012 and 2022, in English and/or Spanish. The search was conducted on November 28, 2022. Systematic reviews, descriptive guides or intervention protocols, and studies that included samples of professional athletes were excluded.

Potential articles were selected based on a set of keywords defined through the PICOS strategy (Participants, Intervention, Comparison, Outcomes, Study design; Liberati et al., 2009) (see Table 2). The search initially focused on the title and abstract.

One reviewer (C.T.B.) carried out the data analysis and the search process in the main databases. All records identified electronically were evaluated by title and abstract. Duplicate articles were removed and considered only once. Full texts were obtained for all articles considered potentially eligible. Subsequently, the preselected records were independently examined by two reviewers (C.T.B. and C.V.), who selected the final studies to be included in the review. In case of disagreement, the opinion of a third reviewer (E.P.) was considered.

Results

Search Results:

After excluding duplicate records, a total of 1,247 potentially relevant publications were considered eligible. Following title and abstract screening, 48 publications were selected for full-text review. Finally, 20 articles were included in this systematic review (Figure 1), 10 of which were randomized controlled trials (RCTs).

Table 1
Terms used for the search

Group 1: Eating disorders	("eating disorder*" OR "disordered eating" OR "eating patholog*") OR ("anorexia nervosa" OR "anorexia" OR "bulimia nervosa" OR "bulimia" OR "avoidant restrictive food intake disorder" OR "other specified feeding or eating disorder" OR "binge eating disorder*") OR ("feeding disorder*" OR "appetite disorder*" OR "eating and feeding disorder*" OR "relative energy deficiency in sport" OR "female athlete triad syndrome")
Group 2: PE and treatment	("exercis*" OR "physical activ*" OR "physical fitness" OR "sport*") AND ("intervent*" OR "treatment*" OR "treatment outcome" OR "inpatient treatment" OR "clinical experience" OR "exercise treatment" OR "therap*" OR "prescription" OR "body-oriented therap*" OR "rehabilitation" OR "prescription")
Group 3: Characteristics of the PE	("endurance training" OR "resistance training" OR "flexibility exercise*" OR "strength" OR "intensity" OR "frequency" OR "duration" OR "type" OR "aerobic exercise*" OR "high-intensity interval training" OR "circuit-based exercise" OR "weightlifting" OR "functional fitness" OR "endurance exercise*" OR "resistance exercise*" OR "HIIT")

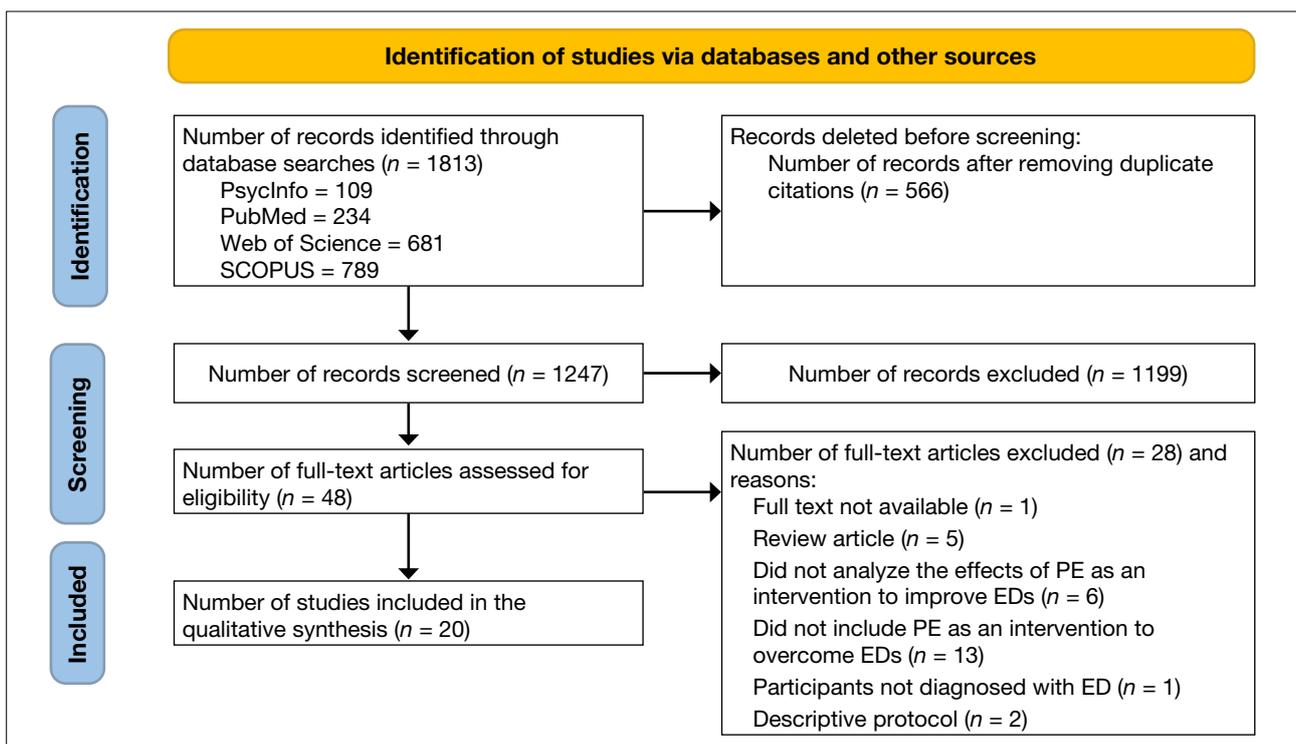
Note. HIIT = High Intensity Interval Training.

Table 2
Key terms defined through the PICOS strategy

PARTICIPANTS	Women and men with a confirmed diagnosis of an eating disorder (AN, BN, BED, OSFED) who have practiced some form of physical activity as part of the ED treatment.
INTERVENTION	Physical activity as the main component or as part of the ED treatment.
COMPARISON	All comparisons and control conditions, as well as studies including a comparison group.
OUTCOMES	Improvement of eating disorder symptomatology and description of the defining aspects of physical activity.
STUDY DESIGN	Non-randomized controlled studies (NRS), randomized controlled trials (RCT), observational studies (OS), case studies (CS), quasi-experimental studies (QES).

Note. AN: Anorexia Nervosa, BN: Bulimia Nervosa, BED: Binge Eating Disorder, OSFED: Other Specified Feeding or Eating Disorder.

Figure 1
Flowchart (Page et al., 2021)



Note. PE = Physical Exercise, ED = Eating Disorder.

Participant Characteristics

The total number of participants across the different studies was 895. Table 3 details their characteristics.

Table 3
Characteristics of the participants

Sample size (range of participants)	1–164
Age range	12.6–60
Sex (<i>n</i> ; %)	
Females	711 (79.4%)
Males	6 (0.7%)
Not specified	178 (19.9%)
Pathologies (<i>n</i>)	
Anorexia nervosa	10
Bulimia nervosa	10
Binge eating disorder	7
Other Specified Feeding or Eating Disorder	2
Number of patients for each pathology (<i>n</i>)	
Anorexia nervosa	285
Bulimia nervosa	298
Binge eating disorder	187
Other Specified Feeding or Eating Disorder	23
Not specified	67
Lost	35

Characteristics of the Interventions

Among the twenty studies reviewed, the duration of the interventions ranged from one to twenty-six weeks. Tables 4 and 5 present, in alphabetical order, the main characteristics of all the reviewed studies.

Effects of Physical Exercise on ED Symptomatology

Effects of physical exercise on physical condition

Thirteen articles analyzed the effects of PE on the physical condition of patients. Regarding physical condition and

abilities, improvements were found in muscle strength of the upper and lower limbs ($n = 6$; Bratland-Sanda et al., 2012; Bratland-Sanda et al., 2018; Dauty et al., 2022; Fernández-del-Valle et al., 2014; Fernández-del-Valle et al., 2015b; Mathisen et al., 2018a); cardiorespiratory improvements ($n = 3$; Dauty et al., 2022; Galasso et al., 2018; Galasso et al., 2020); better balance test results ($n = 1$; Dauty et al., 2022); and improved agility ($n = 2$; Fernández-del-Valle et al., 2014; Fisher & Schenkman, 2012). With regard to anthropometric measures, significant improvements were observed in BMI ($n = 7$; Agne et al., 2022; Bratland-Sanda & Vrabel, 2018; Bratland-Sanda et al., 2018; Dauty et al., 2022; Galasso et al., 2018; Fernández-del-Valle et al., 2015a; Fernández-del-Valle et al., 2015b) and in skinfold thickness ($n = 2$; Agne et al., 2022; Fernández-del-Valle et al., 2015b).

Efficacy of physical exercise on ED symptomatology

Ten articles analyzed the effects of PE on ED symptomatology. One study included aerobic exercise ($n = 1$; Galasso et al., 2018), reporting a decrease in pathological behaviors related to compulsive exercise (CE) and food intake. Another study examined the effects of strength-endurance training on the psychopathological symptoms of BN and BED and on CE-related pathological behaviors after the intervention (Mathisen et al., 2018b).

As for interventions combining strength training and aerobic activities ($n = 3$; Bakland et al., 2019; Bratland-Sanda et al., 2012; Galasso et al., 2020), a significant reduction was observed in the total score of the Eating Disorders Examination (EDE), as well as significant improvements in emotional and cognitive symptoms related to binge eating and a reduction in compensatory behaviors.

Regarding mind-body activities such as yoga ($n = 2$; Brennan et al., 2020; Diers et al., 2020) or Pilates ($n = 1$; Martínez-Sánchez et al., 2020), yoga reduced binge-eating frequency in individuals with BN, decreased emotional dysregulation and self-criticism, improved self-compassion and mindfulness skills, and significantly reduced body-image concerns. Pilates, on the other hand, improved sleep quality.

Other studies allowed participants to choose the type of PE they wished to practice ($n = 2$; Bratland-Sanda & Vrabel, 2018; Lampe et al., 2022). Both reported improvements in ED symptomatology, and one of them also found a reduction in overall psychological distress and a decrease in compulsive PE practice.

Table 4*Main characteristics of the studies included*

Author (year)	Type of study	Sample (age, sex, ED manifestation, comorbidity)	Time of data collection; Description of intervention (type and intensity); Duration and frequency (individual, group, or unspecified training)
Agne et al. (2022)	RCT	$N = 41$ (Age: 12.78 ± 0.88 years, sex n/s, AN) / CG $n = 22$; EG PREx $n = 19$	Pre, post (2 months) CG: CBT + NP EG PREx: CBT + strength training (8 exercises, 3 sets, 10 reps, 70% 6RM or OMNI-Resistance Exercise Scale [OMNI-RES] < 6, 1–2 min rest) + NP with caloric supplement (+150 kcal post-session) 24 sessions over 8 weeks (3 sessions/wk; 50 min/session); (group)
Bakland et al. (2019)	Qualitative study (RCT context)	$N = 15$ (Age: 19–42 years old, females, BN $n = 6$, BED $n = 9$).	16 months after PED-t. PED-t: CBT + strength + endurance training (1 supervised session/wk [n/s] + 1 unsupervised session/wk of pyramidal interval running) + dietary therapy 20 sessions in 4 months (3 sessions/wk; 40–60 min/session); (group)
Bratland-Sanda and Vrabel (2018)	OS	$N = 84$ (Age: 28.1 ± 7.7 years, sex n/s, AN $n = 21$, BN $n = 43$, OSFED $n = 20$) / CE $n = 19$ (Age: 27.7 ± 8.0 years, sex n/s, AN $n = 9$, BN $n = 5$, OSFED $n = 5$)	Pre, during and post. Individual and group CBT + PE intervention (n/s) CE: 1 additional individual counseling session to reduce excessive exercise 12 weeks (2 sessions/wk; 45 min/session); (individual)
Bratland-Sanda et al. (2012)	OS	$N = 29$, females. BMI < 18.5 $n = 7$ (Age: 31.9 ± 9.4 years, AN $n = 3$, BN $n = 1$, OSFED $n = 3$); BMI ≥ 18.5 $n = 22$ (Age: 30.6 ± 9 years, AN $n = 3$, BN $n = 11$, OSFED $n = 11$)	n/s. CBT + psychoeducation + moderate-intensity PE; ball games, walking and Nordic walking, strength exercises (n/s) and horse riding + NP + Art Therapy 12–24 weeks (2 sessions/wk; 60 min/session); (group)
Bratland-Sanda et al. (2018)	CS	$N = 1$ Age: 25 years old, female, restrictive AN, BMI: 17.6, Osteopenia in lumbar spine, menstrual disturbances, CE	Pre, post and follow-up at 6 months. Psychotherapy (psychoeducation, interpersonal, therapeutic, and social support) + strength training (Maximal Strength Training intervention [4 exercises, 3 sets, 5RM, 3 min rest]) 48 sessions in 16 weeks (3 sessions/wk; 60 min/session); (individual)
Brennan et al. (2020)	RCT	$N = 53$ (Age n/s, females, BN or BED) / EG $n = 26$; CG $n = 27$	Pre, post CG: (n/s) EG: Yoga 8 sessions in 8 weeks (1 session/wk; 90 min/session); (group)

Note. AN = Anorexia Nervosa, BED = Binge Eating Disorder, BN = Bulimia Nervosa, CBT = Cognitive Behavioral Therapy, CE = Compulsive Exercise, CG = Control Group, CS = Case Study, DERS = Difficulties in Emotion Regulation Scale, EG = Experimental Group, FSCRS = Forms of Self-Criticizing/Attacking and Self-Reassuring Scale, NRS = Non-Randomized Controlled Studies, NP = Nutritional Plan, n/s = Not Specified, OS = Observational Study, OSFED = Other Specified Feeding or Eating Disorder, PED-t = Physical Exercise and Dietary Therapy, QES = Quasi-Experimental Study, RCT = Randomized Controlled Trial, ROM = Range of Motion, SCS-SF = Self-Compassion Scale – Short Form, TMS = Toronto Mindfulness Scale.

Table 4 (continued)

Main characteristics of the studies included

Author (year)	Type of study	Sample (age, sex, ED manifestation, comorbidity)	Time of data collection; Description of intervention (type and intensity); Duration and frequency (individual, group, or unspecified training)
Dauty et al. (2022)	OS	$N = 37$ (Age: 32 ± 11 years, females $n = 34$, restrictive AN $n = 13$, purging AN $n = 9$, AN with history of bulimic episodes $n = 11$, AN with hyperactivity $n = 4$, Hyperactivity $n = 17$).	Pre, post and follow-up at 12 months Psychotherapy + psychiatric treatment + stretching + neuromuscular training + relaxation + strength training (3–5 sets, 6–10 reps, 1 min rest) + functional exercises + varied physical activities (3 sessions/week; badminton, billiards, table tennis, archery, volleyball, swimming, walking, cycling) 4 weeks, 5 days/week (2 sessions/day, 60 min/session); (n/s)
Diers et al. (2020)	Mixed methods	$N = 67$ (Age n/s, females $n = 66$, ED manifestation n/s)	Pre, during and post Yoga (therapeutic yoga + group discussion) 8 sessions 8 weeks (1 session/wk; 90 min/session); (group)
Fernández-del-Valle et al. (2015a)	RCT	$N = 44$, females / CG $n = 22$ (Age: 13.0 ± 0.6 years, females, restrictive AN); EG $n = 22$ (Age: 12.7 ± 0.6 years, females, restrictive AN)	Pre, post. CG: Psychotherapy + NP EG: Psychotherapy + NP with caloric adjustment + Strength Work (8 exercises, 3 sets, 8–10 reps, 70% of 6 RM, 1–2' rest, according to National Strength and Conditioning Association guidelines 24 sessions in 8 weeks (3 sessions/wk; 50–60 min/session); (group)
Fernández-del-Valle et al. (2015b)	RCT	$N = 44$, females / CG $n = 22$ (Age: 12.6 ± 0.6 years, restrictive AN, days from hospitalization to inclusion: 50.8 ± 36.4 days); EG $n = 22$ (Age: 13.0 ± 0.6 years, restrictive AN, days from hospitalisation to inclusion: 61.5 ± 37.3 days) Final sample $N = 36$ (EG $n = 18$ and CG $n = 18$)	Pre, post and follow-up at 4 weeks CG: Psychotherapy + NP EG: Psychotherapy + NP with calorie adjustment + Strength work (8 exercises, 3 sets, 8–10 reps, 70% of 6 RM, 1–2' rest) 24 sessions over 8 weeks (3 sessions/wk; 50–60 min/session); (n/s)
Fernández-del-Valle et al. (2014)	RCT	$N = 36$, females / CG $n = 18$ (Age: 13.0 ± 0.60 years; females; restrictive AN); EG $n = 18$ (Age: 12.6 ± 0.59 years; restrictive AN)	Pre, post (8 weeks) and follow-up at 4 weeks CG: Psychotherapy + NP EG: Psychotherapy + NP with calorie adjustment + Strength work (8 exercises, 3 sets, 8–10 reps, 70% of 6 RM, 1–2' rest) 24 sessions in 8 weeks (3 sessions/wk; 50–60 min/session); (group)
Fisher and Schenkman (2012)	CS	$N = 1$ (Age: 48 years; female; AN; hypothermia, hyponatremia, hypoglycemia, starvation-induced hepatitis, vitamin D deficiency, coagulopathy, vitamin K deficiency, amenorrhea, refeeding syndrome, exertional tachycardia, and stage-1 pressure ulcer.	Pre, post Strength training (following the guidelines of the American College of Sports Medicine for frail older adults) + ROM/flexibility + postural stability + strength and functional strength training 9 weeks (4–6 sessions/wk, 1 session/day; 30 min/session); (individual)

Note. AN = Anorexia Nervosa, BED = Binge Eating Disorder, BN = Bulimia Nervosa, CBT = Cognitive Behavioral Therapy, CE = Compulsive Exercise, CG = Control Group, CS = Case Study, DERS = Difficulties in Emotion Regulation Scale, EG = Experimental Group, FSCRS = Forms of Self-Criticizing/Attacking and Self-Reassuring Scale, NRS = Non-Randomized Controlled Studies, NP = Nutritional Plan, n/s = Not Specified, OS = Observational Study, OSFED = Other Specified Feeding or Eating Disorder, PED-t = Physical Exercise and Dietary Therapy, QES = Quasi-Experimental Study, RCT = Randomized Controlled Trial, ROM = Range of Motion, SCS-SF = Self-Compassion Scale – Short Form, TMS = Toronto Mindfulness Scale.

Table 4 (continued)

Main characteristics of the studies included

Author (year)	Type of study	Sample (age, sex, ED manifestation, comorbidity)	Time of data collection; Description of intervention (type and intensity); Duration and frequency (individual, group, or unspecified training)
Galasso et al. (2018)	RCT	$N = 14$ (Age n/s, females $n = 11$, BED $n = 14$) / CG $n = 8$ (Age: 58 ± 13 years); EG $n = 6$ (Age: 45 ± 16 years)	Pre- and follow-up 6 months after completion of intervention CG: CBT + NP EG: CBT + NP + Endurance work (brisk walking) 6 months (4 sessions/wk; 90 min/session of aerobic activity); (group)
Galasso et al. (2020)	RCT	$N = 19$ females / CG $n = 9$ (Age: 53 ± 13 years, BED); CE CAAET $n = 10$ (Age: 54 ± 11 years, BED)	Pre- and follow-up 6 months after completion of intervention CG: CBT + NP EG CAAET: CBT + NP + Endurance work (brisk walking) + Strength work 24 sessions in 6 weeks (4 sessions/wk; 90 min/session); (group)
Lampe et al. (2022)	Series of proof-of-concept cases	$N = 3$ females (Age: 18–60 years, BN or subthreshold BN)	Pre, during (week 4, treatment) and post (week 12) CBT + PE (weekly goals of moderate-to-vigorous intensity PA) 12 sessions in 12 weeks (1 session/wk); (n/s)
Martin et al. (2017)	RCT	$N = 41$ (Age: n/s, females $N = 39$ AN) / CG $n = 21$ (Age: 16.8 ± 2.3 years, Sex n/s); EG $n = 20$ (Age: 16.8 ± 2.4 years, Sex n/s).	Days 0–3 (T1), days 4–6 (T2) and days 7–9 (T3). Blood analysis with a 3-day interval between blood draws during hospitalization: days 1–3 (T1), days 4–6 (T2), and days 7–9 (T3). CG: NP + Standard care EG: NP + Standard care + 24-hour bed rest monitoring + High impact, low frequency exercise: 20 vertical jumps of 5 inches off the ground 9 days (2 sessions/day; 5 min/session); (n/s)
Martínez-Sánchez et al. (2020)	QES	$N = 12$ (Age: 14.6 ± 1.7 years; females; restrictive AN $n = 11$, atypical AN $n = 1$).	Pre, post Pilates (range of motion, strength, balance and coordination); 10 reps/exercise 10 weeks (3 sessions/wk; 60 min/session); (group)
Mathisen et al. (2018a) ¹	RCT	$N = 164$ females / CG $n = 73$ (Age: 27.8 ± 5.3 years, BN $n = 51$, BED $n = 27$); EG $n = 76$ (Age: 28.3 ± 6.2 years, BN $n = 51$, BED $n = 27$)	Pre, post and follow-up (at 6 and 12 months) CG: CBT EG (PED-t): CBT + maximal muscle strength training (progressive resistance; 10 RM – 2 RM) + strength-endurance training (HIIT, pyramidal intensity structure according to general cardiorespiratory fitness recommendations) + nutritional psychoeducation 16 weeks, 20 sessions (2 sessions/wk; 90 min/session); (group)

Note. AN = Anorexia Nervosa, BED = Binge Eating Disorder, BN = Bulimia Nervosa, CBT = Cognitive Behavioral Therapy, CE = Compulsive Exercise, CG = Control Group, CS = Case Study, DERS = Difficulties in Emotion Regulation Scale, EG = Experimental Group, FSCRS = Forms of Self-Criticizing/Attacking and Self-Reassuring Scale, NRS = Non-Randomized Controlled Studies, NP = Nutritional Plan, n/s = Not Specified, OS = Observational Study, OSFED = Other Specified Feeding or Eating Disorder, PED-t = Physical Exercise and Dietary Therapy, QES = Quasi-Experimental Study, RCT = Randomized Controlled Trial, ROM = Range of Motion, SCS-SF = Self-Compassion Scale – Short Form, TMS = Toronto Mindfulness Scale.

Table 4 (continued)

Main characteristics of the studies included

Author (year)	Type of study	Sample (age, sex, ED manifestation, comorbidity)	Time of data collection; Description of intervention (type and intensity); Duration and frequency (individual, group, or unspecified training)
Mathisen et al. (2018b) ²	RCT	<i>N</i> = 156 females (BN <i>n</i> = 103, BED <i>n</i> = 53) / CG <i>n</i> = 23 (Age: 26.5 ± 5.6 years, BN <i>n</i> = 20, BED <i>n</i> = 3); G CBT <i>n</i> = 73 (Age: 27.7 ± 5.3 years, BN <i>n</i> = 48, BED <i>n</i> = 25); EG PED-t <i>n</i> = 76 (Age: 28.2 ± 6.2 years, BN <i>n</i> = 49, BED <i>n</i> = 27)	Pre, post and follow-up (at 6 and 12 months) CG: no intervention G CBT: CBT; 1–2 sessions/wk for 16 weeks; total of 20 sessions EG PED-t: Dietary treatment + theoretical sessions on exercise physiology and exercise principles + strength and strength-endurance training (1–2 supervised strength sessions/week combined with dietary therapy + 2 unsupervised sessions/week [1 strength session + 1 HIIT session]) 20 sessions over 16 weeks (1–2 supervised sessions/week + 2 unsupervised sessions/week); (n/s)
Vancampfort et al. (2014a)	Exploratory one-group repeated measures	<i>N</i> = 34 females (<i>n</i> = 31) (Age: 38.5 ± 10.7 years, BED) completed the 6-month program	Pre and follow-up (at 3 and 6 months) CBT, 1 session/wk; 105 min/session + PE intervention; (n/s). 6 months (1 session/wk; 60 min/session); (group)

Note. AN = Anorexia Nervosa, BED = Binge Eating Disorder, BN = Bulimia Nervosa, CBT = Cognitive Behavioral Therapy, CE = Compulsive Exercise, CG = Control Group, CS = Case Study, DERS = Difficulties in Emotion Regulation Scale, EG = Experimental Group, FSCRS = Forms of Self-Criticizing/Attacking and Self-Reassuring Scale, NRS = Non-Randomized Controlled Studies, NP = Nutritional Plan, n/s = Not Specified, OS = Observational Study, OSFED = Other Specified Feeding or Eating Disorder, PED-t = Physical Exercise and Dietary Therapy, QES = Quasi-Experimental Study, RCT = Randomized Controlled Trial, ROM = Range of Motion, SCS-SF = Self-Compassion Scale – Short Form, TMS = Toronto Mindfulness Scale.

Table 5
 Characteristics of the included studies: instruments and main results

Author (year)	Instruments and measures	Results
Agne et al. (2022)	Accelerometer; graded exercise test on ergometer; 6RM strength test; SF-36; BMI; Anthropometry.	Improvements in quality of life in CG and SG, with larger effects in SG. The EG improved anthropometric differences without affecting skinfolds, body weight, or BMI.
Bakland et al. (2019)	Semi-structured interview.	Improvement in knowledge and in the application of PE and nutrition; positive evaluation of the support received during the intervention.
Bratland-Sanda and Vrabell (2018)	EDE-Q; SCL-5; BMI.	Significant reduction in EDE-Q and SCL-5 scores, and in exercise, along with an increase in BMI.
Bratland-Sanda et al. (2012)	EDE v12; EDI v2; accelerometer; Bruce treadmill protocol; 1RM test; body composition; BMI; DXA.	Patients with BMI < 18.5: increase in lower-body muscle strength, mean total body mass, fat mass, lean body mass, and BMI. Patients with BMI ≥ 18.5: increase in upper-body muscle strength, fat mass, and BMI. Positive correlation between BMI and the EDI subscales of body dissatisfaction and bulimia, and negative correlation with the EDE restraint subscale.
Bratland-Sanda et al. (2018)	EDE v16; CET; 1RM test (half squats and bench press); BMD; DXA; energy intake (kcal/day) and daily PA (min/week); questionnaire on the intervention.	Improvement in the 1RM test and in BMD, with self-perceived psychological benefits. No changes were observed in menstrual dysfunction, weight, EDE, or CET.
Brennan et al. (2020)	EDE-Q 6.0; DERS; FSCRS; SCS-SF; TMS; ATSPPH-SF.	Only the EG showed improvements in binge-eating episode frequency, emotion regulation difficulties, self-criticism, self-compassion, and the ability to achieve mindfulness.
Dauty et al. (2022)	BMI; muscle strength (knee, biceps and triceps brachii, and handgrip); Shirado-Ito test; Biering-Sorensen test; balance; 6MWT; spirometry; hip DXA.	Weight gain, BMI, fat mass (trunk, upper and lower limbs) and BMD parameters remain stable. Significant improvement in walking distance, balance, respiratory function, upper- and lower-limb strength, and trunk strength endurance.
Diers et al. (2020)	BSQ; 5 self-developed open-ended questions.	Improved BSQ scores, mixed responses on post-intervention self-perception of body image.
Fernández-del-Valle et al. (2015a)	6RM test (bench press, leg press, and lateral row). ISAK anthropometry: BMI, TSF (mm), MTSF (mm), MUAC (cm), and MTC (cm); AMA (cm ²) and MTMA (cm ²) calculated using Heymsfield equations.	In the post-training phase, the EG was in higher percentile categories for MUAC and MTC compared with the CG, and AMA either increased or remained within the same range.

Note. AG = android-to-gynoid fat mass ratio; ALPHA Fitness Battery = Assessing Levels of Physical Activity and Fitness; AMA = Arm Muscle Area; Anthropometry ISAK = Anthropometry following International Standards for the Advancement of Kinanthropometry; AROM = Active Range of Motion; ATSPPH-SF = Attitudes Toward Seeking Professional Psychological Help – Short Form; Bd = Body Density; BES = Binge Eating Scale; BIA = Bioelectrical Impedance Analysis; BITE = Bulimic Investigatory Test, Edinburgh; BMD = Bone Mineral Density; BMI = Body Mass Index; BP = Blood Pressure; BPA = Baecke Physical Activity Questionnaire; BSAP = Bone-Specific Alkaline Phosphatase; BSQ = Body Shape Questionnaire; CBT = Cognitive Behavioral Therapy; CE = Compulsive Exercise; CET = Compulsive Exercise Test; CRF = Cardiorespiratory Fitness; DERS = Difficulties in Emotion Regulation Scale; DXA = Dual-Energy X-ray Absorptiometry; EDE v12 = Eating Disorder Examination v12; EDE v16 = Eating Disorder Examination v16; EDE-Q v6 = Eating Disorder Examination Questionnaire v6.0; EDI = Eating Disorder Inventory v2; EMA = Ecological Momentary Assessment; FIM = Functional Independence Measure; FM = Fat Mass; FSCRS = Forms of Self-Criticizing/Attacking and Self-Reassuring Scale; HR = Heart Rate; MTMA = Mid-Thigh Muscle Area; MTC = Mid-Thigh Circumference; MTSF = Mid-Thigh Skinfold Thickness; MUAC = Mid-Upper Arm Circumference; NTX = Serum N-Telopeptide; PANAS = Positive and Negative Affect Schedule; PED-t = Physical Exercise and Dietary Therapy; POMA = Performance-Oriented Mobility Assessment; PSPP = Physical Self-Perception Profile; SCL-5 = Symptom Checklist-5; SCS-SF = Self-Compassion Scale – Short Form; SF-36 = 36-Item Short Form Health Survey; SMM = Skeletal Muscle Mass; ST = Strength Test; TMS = Toronto Mindfulness Scale; TSF = Triceps Skinfold Thickness; TUDS = Timed Up and Down Stairs Test; TUG = Timed Up and Go Test; VAT = Visceral Adipose Tissue; VSS = Vital Signs Stable; 3MWT = 3 Minutes Walking Test; 6MWT = 6 Minutes Walking Test; %BF = relative body fat.

Table 5 (continued)

Characteristics of the included studies: instruments and main results

Author (year)	Instruments and measures	Results
Fernández-del-Valle et al. (2015b)	6RM test (bench press, leg press, and lateral row); body weight (kg); height (m); skinfolds: biceps, triceps, subscapular, and suprailiac (mm); thigh, arm, and calf circumferences (cm); BMI; Durnin equation (Bd); Heyward equation (%BF); Poortmans equation (SMM).	Increase in BMI, skeletal muscle mass and relative strength in EG. Increases in fat mass in the CG. The group effect was not significant for SMM, FM, or %BF.
Fernández-del-Valle et al. (2014)	Accelerometer; graded treadmill test; BMI; muscle strength (seated bench press, seated lateral row, seated leg press); 3-m and 10-m TUG; TUDS.	Significantly greater improvement in the EG compared with the CG after the intervention in leg press, bench press, and lateral row, as well as beneficial effects on agility.
Fisher and Schenkman (2012)	Musculoskeletal system: Upper/lower quartile screening, weight, height, BMI, numerical rating scale. Neuromuscular system: light sensitivity, AROM, observation Cardiopulmonary system: Cardiopulmonary system: BP, resting HR, activity HR, oxygen saturation. Integumentary system: ulcer identification. Cognitive system: orientation x3. Others: blood glucose level, dual-energy X-ray absorptiometry test; FIM, TUG(s), POMA, 3MWT.	Mean gain of 1.32 kg/week; recovery of independence in daily activities (improvements in FIM); improvements in POMA (postural stability Pre = 17; Post = 24), in TUG score (Pre = 19.27; Post = 11.00 s), and in walking speed (Pre = 0.35; Post = 0.81 m/s).
Galasso et al. (2018)	BMI; 6MWT	Non-significant greater reduction in BMI and 6MWT in the EG compared with the CG.
Galasso et al. (2020)	BMI; BES; BITE; 6MWT; ST.	Improvement in both CG and EG in anthropometric measures, ED symptoms, and exercise capacity. Significantly greater improvement in the EG compared with the CG
Lampe et al. (2022)	EDE-Q; EDE subscales: Shape Concern and Weight Concern; EMA; PANAS; accelerometer; item on weekly duration of moderate-to-vigorous PA.	Reduction in weight and shape concern, negative affect, and binge and compensatory/purging episodes. Weekly PE goals were not achieved, and perceived control over weight did not decrease.
Martin et al. (2017)	Sociodemographic questionnaire; physical examination; blood analysis (sex steroids and vitamin D); BMI. Measurement of vital signs every 4 hours; pulse and blood pressure at rest after 5 minutes of rest and after standing for 2 minutes.	Significantly greater reduction in VSS in the EG compared with the CG, but no differences in BSAP, NTX, osteocalcin, weight, or length of stay.

Note. AG = android-to-gynoid fat mass ratio; ALPHA Fitness Battery = Assessing Levels of Physical Activity and Fitness; AMA = Arm Muscle Area; Anthropometry ISAK = Anthropometry following International Standards for the Advancement of Kinanthropometry; AROM = Active Range of Motion; ATSPPH-SF = Attitudes Toward Seeking Professional Psychological Help – Short Form; Bd = Body Density; BES = Binge Eating Scale; BIA = Bioelectrical Impedance Analysis; BITE = Bulimic Investigatory Test, Edinburgh; BMD = Bone Mineral Density; BMI = Body Mass Index; BP = Blood Pressure; BPA = Baecke Physical Activity Questionnaire; BSAP = Bone-Specific Alkaline Phosphatase; BSQ = Body Shape Questionnaire; CBT = Cognitive Behavioral Therapy; CE = Compulsive Exercise; CET = Compulsive Exercise Test; CRF = Cardiorespiratory Fitness; DERS = Difficulties in Emotion Regulation Scale; DXA = Dual-Energy X-ray Absorptiometry; EDE v12 = Eating Disorder Examination v12; EDE v16 = Eating Disorder Examination v16; EDE-Q v6 = Eating Disorder Examination Questionnaire v6.0; EDI = Eating Disorder Inventory v2; EMA = Ecological Momentary Assessment; FIM = Functional Independence Measure; FM = Fat Mass; FSCRS = Forms of Self-Criticizing/Attacking and Self-Reassuring Scale; HR = Heart Rate; MTMA = Mid-Thigh Muscle Area; MTC = Mid-Thigh Circumference; MTSF = Mid-Thigh Skinfold Thickness; MUAC = Mid-Upper Arm Circumference; NTX = Serum N-Telopeptide; PANAS = Positive and Negative Affect Schedule; PED-t = Physical Exercise and Dietary Therapy; POMA = Performance-Oriented Mobility Assessment; PSPP = Physical Self-Perception Profile; SCL-5 = Symptom Checklist-5; SCS-SF = Self-Compassion Scale – Short Form; SF-36 = 36-Item Short Form Health Survey; SMM = Skeletal Muscle Mass; ST = Strength Test; TMS = Toronto Mindfulness Scale; TSF = Triceps Skinfold Thickness; TUDS = Timed Up and Down Stairs Test; TUG = Timed Up and Go Test; VAT = Visceral Adipose Tissue; VSS = Vital Signs Stable; 3MWT = 3 Minutes Walking Test; 6MWT = 6 Minutes Walking Test; %BF = relative body fat.

Table 5 (continued)

Characteristics of the included studies: instruments and main results

Author (year)	Instruments and measures	Results
Martínez-Sánchez et al. (2020)	BIA; blood biochemical composition; accelerometer; ALPHA-Fitness Battery: handgrip strength, upper-body strength, standing long jump test, 4x10 m shuttle run test, 20 m shuttle run test.	After the program, height, plasma calcium, and sleep efficiency increased significantly, while plasma follicle-stimulating hormone, sleep duration, and nighttime disturbances decreased. Overall, no differences were detected in body composition.
Mathisen et al. (2018a) ¹	Seca scale, dual-energy X-ray absorptiometry, fat mass, %fat mass, lean body mass, VAT, WHR, BMD; CRF; 1RM test: Smith machine squats, bench press, and seated cable row; categorization into high-risk groups for non-communicable disease if at least two of the three high-risk assessment categories are met: (1) elevated BMI, high body fat percentage, or masked obesity; (2) elevated VAT levels; and/or (3) low VO ₂ peak.	Improvement in the EG compared with the CG (with moderate to large effect sizes) in mean absolute VO ₂ peak, 1RM test for squat, bench press, and seated row, proximal femur BMD, and proximal femur BMD-Z. Body composition deteriorated in both groups during follow-up. Neither PED-t nor CBT reduced the risk of non-communicable diseases.
Mathisen et al. (2018b) ²	EDE-Q; CET; ActiGraph Accelerometer	Reduction in EG of CE from baseline, but no difference with CG. The proportion of participants meeting the official PA recommendation did not change or differ between groups after the intervention.
Vancampfort et al. 2014a)	EDE-Q; 6MWT; SF-36; BPA; PSPP	Significant improvement in all parameters (except occupational PA, physical strength, and self-esteem) after 6 months. Increased participation in sports activities (large effect size) and a reduction (small effect size) in the number of binge episodes, which was associated with significant improvements in quality of life. Significant increases in leisure-time PA (BPA) were associated with significant improvements in quality of life (SF-36) and increased perceived sport competence, physical condition, and body attractiveness.

Note. AG = android-to-gynoid fat mass ratio; ALPHA Fitness Battery = Assessing Levels of Physical Activity and Fitness; AMA = Arm Muscle Area; Anthropometry ISAK = Anthropometry following International Standards for the Advancement of Kinanthropometry; AROM = Active Range of Motion; ATSPPH-SF = Attitudes Toward Seeking Professional Psychological Help – Short Form; Bd = Body Density; BES = Binge Eating Scale; BIA = Bioelectrical Impedance Analysis; BITE = Bulimic Investigatory Test, Edinburgh; BMD = Bone Mineral Density; BMI = Body Mass Index; BP = Blood Pressure; BPA = Baecke Physical Activity Questionnaire; BSAP = Bone-Specific Alkaline Phosphatase; BSQ = Body Shape Questionnaire; CBT = Cognitive Behavioral Therapy; CE = Compulsive Exercise; CET = Compulsive Exercise Test; CRF = Cardiorespiratory Fitness; DERS = Difficulties in Emotion Regulation Scale; DXA = Dual-Energy X-ray Absorptiometry; EDE v12 = Eating Disorder Examination v12; EDE v16 = Eating Disorder Examination v16; EDE-Q v6 = Eating Disorder Examination Questionnaire v6.0; EDI = Eating Disorder Inventory v2; EMA = Ecological Momentary Assessment; FIM = Functional Independence Measure; FM = Fat Mass; FSCRS = Forms of Self-Criticizing/Attacking and Self-Reassuring Scale; HR = Heart Rate; MTMA = Mid-Thigh Muscle Area; MTC = Mid-Thigh Circumference; MTSF = Mid-Thigh Skinfold Thickness; MUAC = Mid-Upper Arm Circumference; NTX = Serum N-Telopeptide; PANAS = Positive and Negative Affect Schedule; PED-t = Physical Exercise and Dietary Therapy; POMA = Performance-Oriented Mobility Assessment; PSPP = Physical Self-Perception Profile; SCL-5 = Symptom Checklist-5; SCS-SF = Self-Compassion Scale – Short Form; SF-36 = 36-Item Short Form Health Survey; SMM = Skeletal Muscle Mass; ST = Strength Test; TMS = Toronto Mindfulness Scale; TSF = Triceps Skinfold Thickness; TUDS = Timed Up and Down Stairs Test; TUG = Timed Up and Go Test; VAT = Visceral Adipose Tissue; VSS = Vital Signs Stable; 3MWT = 3 Minutes Walking Test; 6MWT = 6 Minutes Walking Test; %BF = relative body fat.

Discussion

This review provides evidence that physical exercise (PE) can serve as an effective therapeutic tool for patients diagnosed with an eating disorder (ED). It shows that the prescription of PE, when supervised by professionals and implemented by a multidisciplinary team, can be safe and offer multiple benefits for individuals with such disorders (Cook et al., 2016).

Improvements in ED Symptomatology Through the Inclusion of PE in Treatment

A total of 35% of the studies ($n = 7$) did not describe the intervention characteristics in sufficient detail (for example, the volume or intensity of PE), providing only general information about the type of PE (e.g., Bakland et al., 2019; Mathisen et al., 2018b). Furthermore, the instruments used to assess symptomatology were heterogeneous (e.g., EDE-Q [Eating Disorder Examination Questionnaire], BITE [Bulimic Investigatory Test Edinburgh], BSQ [Body Shape Questionnaire], and semi-structured interviews), as each focused on different dimensions.

In this regard, in the present systematic review, the effectiveness of the interventions could not be determined based on specific improvements in ED symptomatology; it could only be examined according to the degree of adherence and the changes in reported outcomes obtained after the PE program. Nevertheless, even though the efficacy

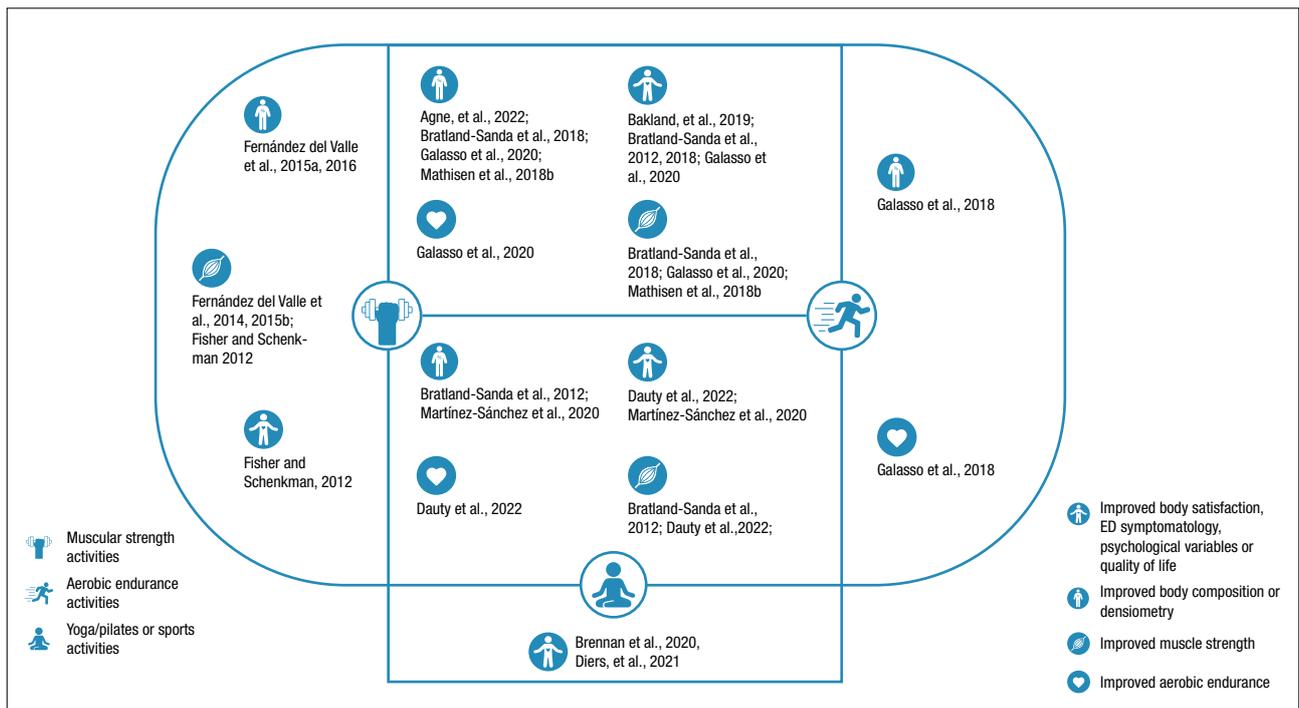
criteria were not standardized, only one study concluded that including PE in the treatment for EDs was not more or equally effective in experimental groups compared to CG (Mathisen et al., 2018b).

In this case, as the authors themselves point out, the lack of significant differences could be due to the low statistical power resulting from the small sample size and the high dropout rate in the control group. The remaining studies concluded that prescribed exercise provided greater efficacy.

As illustrated in Figure 2, the results indicated both psychological and physical benefits after performing PE as part of ED treatment. Consequently, the findings suggest that PE therapy for patients with EDs (AN, BN, BED, or OSFED) is safe and beneficial for both ED symptomatology and overall physical and mental health, although identifying a single specific type of PE remains challenging (Mathisen et al., 2023; Toutain et al., 2022). In this regard, strength training targeting major muscle groups showed significant increases in strength based on the 5RM test after 16 weeks of weight training and the 70% 6RM test after 8 weeks (Bratland-Sanda et al., 2018; Fernández-del-Valle et al., 2014). Previous reviews involving AN patients have also confirmed improvements in muscle strength through PE with resistance training, both with and without weights, after 12 weeks of training, and through bench press and leg press tests following 8 weeks of high-intensity strength training (Miñano-Garrido et al., 2022).

Figure 2

Synthesis of studies showing improvements in ED symptomatology, body composition, and physical fitness according to the type of PE applied in treatment



More specifically, Vancampfort et al. (2014b) concluded that a program combining aerobic and strength-endurance training for patients with AN and BN resulted in increased muscle strength, BMI, and body fat percentage. Similar findings were observed in non-clinical samples. Recent review studies, such as Mikkonen et al. (2024), indicate that regular strength and endurance training leads to gains in both strength and endurance capacity in healthy adult women.

However, in addition, a combined program including aerobic exercise, yoga, and basic body-awareness therapy in patients with AN and BN promoted reductions in eating disorder symptomatology and depressive symptoms. Notably, this review identified a larger number of studies analyzing the benefits of strength and aerobic-resistance training. It is particularly important to highlight the difficulty and complexity of performing aerobic exercise in patients with AN, since excessively intense activity—especially aerobic modalities such as running or swimming—may be inappropriate for individuals with severe malnutrition due to its high energy expenditure requirements, which could lead to further weight loss or other medical risks (Heinl, 2018). Moreover, aerobic PE is generally avoided in the care of patients with AN, as they often show a strong drive for physical activity and an inability to remain still—commonly referred to as a "drive for activity."

It should be noted that although, in individuals with an ED, the goal is usually to restore BMI by increasing it, Galasso et al. (2018) reported an improvement in aerobic capacity but also a reduction in BMI, possibly because the sample consisted of patients diagnosed with BED who presented obesity (BMI \geq 30). Similarly, Martínez-Sánchez et al. (2020) found no changes in body composition or physical condition after the Pilates program, although they did observe a slight increase in BMI percentile among women with higher weight. This was likely because the participants were adolescents and possibly in a period of restoration and stabilization of body composition, so Pilates helped maintain this stability. In fact, Kibar et al. (2016) found that an 8-week Pilates program in healthy women had beneficial effects on muscle strength (abdominal and lumbar), as well as on static balance and flexibility. It should also be noted that the present review did not identify physical changes after Pilates or yoga interventions, as the variables evaluated in these studies focused on behavioral aspects rather than physical condition (Brennan et al., 2020; Diers et al., 2020).

At the physiological level, as in healthy women (Hsu et al., 2024), PE was also found to improve bone health in women with EDs, who often show low bone mineral density (BMD), deteriorated bone structure, and reduced bone strength (Bratland-Sanda et al., 2018; Mathisen et

al., 2018b)—effects that may be further worsened by the negative influence of antidepressants (DiVasta et al., 2017). It will be important to take BMD values into account, as low levels increase the risk of osteoporosis and, consequently, the likelihood of experiencing pain and fractures in adulthood (Lopes et al., 2022).

Among the experimental studies in this review, a reduction was recorded in compulsive exercise, the drive for thinness, and bulimic symptoms in ED patients who engaged in PE. Improvements were also observed in body satisfaction (Bakland et al., 2019; Bratland-Sanda & Vrabel, 2018; Diers et al., 2020), as well as in mood, quality of life, and well-being (Agne et al., 2022; Bakland et al., 2019; Brennan et al., 2020; Vancampfort et al., 2014a). The mental benefits and improvements in pathological behaviors related to CE reported by Bakland et al. (2019) and Mathisen et al. (2018b) were likely due to the fact that therapeutic exercise treatment can help reduce patients' anxiety and "drive for thinness," decrease compulsive engagement in exercise, provide enjoyment, and contribute to better mood and body image (Cook et al., 2011; Vancampfort et al., 2014b).

Characteristics of PE for Improving ED Symptomatology in Treatment

This review revealed substantial variability and a lack of systematization in PE prescription—similar to the findings of the systematic review by Moola et al. (2013)—making it difficult to determine specific characteristics or guidelines for incorporating PE into ED treatment.

Focusing on training variables, and specifically on external load, these were heterogeneous. Regarding intensity and volume in strength training, most programs applied moderate loads (around 50% of 1RM or 70% of 6RM, with 6–15 repetitions and 1–5 sets; Agne et al., 2022; Fernández-del-Valle et al., 2015a). For strength-endurance training, loads were not specified (Mathisen et al., 2018b), while for range-of-motion exercises, work durations of 15–60 seconds and 2–4 sets were reported (Dauty et al., 2022; Fisher & Schenkman, 2012). On the other hand, similarities were found in the strength exercises included, as most involved multi-joint movements and large muscle groups (e.g., seated row, bench press, leg press, leg extension, lat pulldown, trunk curl, back extension, and push-ups; Bratland-Sanda et al., 2018; Fernández-del-Valle et al., 2015a). As for aerobic activity, the interventions were much more diverse, both in activity type (e.g., varied sports; Dauty et al., 2022) and in structure—pyramidal intervals (Bakland et al., 2019), high-intensity intervals (Mathisen et al., 2018b)—and in external load. Despite this heterogeneity, the programs produced beneficial effects.

Cook et al. (2016) concluded that tailoring the exercise mode to individual needs is one of the most therapeutically important principles. Therefore, applying the principle of individualization is key, including the type of exercise itself. In this sense, authors such as Bratland-Sanda and Vrabell (2018), Lampe et al. (2022), or Vancampfort et al. (2014a) allowed participants to choose their preferred activity type and found improvements in ED psychopathology and quality of life, likely due to increased motivation to engage in enjoyable activities. It is important to note that factors such as enjoyment, motivation, choice, social interaction, and sense of belonging (White et al., 2018) also influence the relationship between physical activity and mental health.

On the other hand, mind-body interventions (e.g., pilates or yoga) have also been used as treatment in EDs, as they appear to positively influence body image and reduce ED symptomatology (Hall et al., 2016; Vancampfort et al., 2014a). In fact, Sánchez and Munguía-Izquierdo (2017) stated that yoga has the potential to promote body self-awareness—that is, the ability to experience the body from within through meditation, physical movement, and breathing.

The heterogeneity of PE characteristics identified in this review may also be explained by the inclusion of various ED diagnoses (AN, BN, OSFED, and BED), unlike previous reviews that focused on a single manifestation (Toutain et al., 2022). The spectrum of eating-related behavior differs depending on diagnosis, suggesting that each ED type requires a specific exercise prescription adapted to its particularities.

Given all the above and the difficulty of determining common PE guidelines for ED patients, it is proposed that before initiating exercise in these individuals, it is necessary to reconsider what physical activity means to them, as the personal meaning of PE must change (Cook et al., 2016). The goal is not to eliminate exercise from daily life but to educate the person to understand movement as a complement to psychotherapy or nutrition. Thus, when individuals return to the gym or resume PE after recovery, they will perceive the activity as enjoyable and healthy. If this shift in perspective is not addressed, there is also a risk that the ED may become chronic (Rizk et al., 2020) or that maladaptive exercise patterns may increase the risk of injury. For these reasons, and as a final conclusion, PE should not be withdrawn from ED patients but rather adapted and ensured to be carried out under supervision and with the approval of both a therapist and a qualified exercise professional.

Limitations

Despite the contributions of the present work, some limitations should be mentioned. On the one hand, in some

cases the studies did not specify what type of stimuli were used or provided little detail regarding the training variables applied to the patient. On the other hand, the heterogeneity of the interventions in terms of analyzed variables, content, duration, and assessment timing made it difficult to compare the results among studies, highlighting the need for further research. Likewise, in order to obtain a substantial number of articles for the review, studies with different methodological designs were included, many of them with limited sample sizes and heterogeneous use of assessment measures and instruments.

Conclusions

This systematic review summarizes the evidence that participation in structured PE programs (aerobic endurance, muscle strength, strength-endurance, or yoga exercises) can be highly beneficial for this clinical population, as it reduces ED symptomatology, improves quality of life and psychological well-being, increases muscle strength and cardiorespiratory capacity, and enhances BMD and anthropometric measures. However, there is still insufficient research to develop a systematic and standardized methodology for prescribing PE as an adjunctive treatment for EDs. Moreover, the inclusion of various ED manifestations in this review made it difficult to identify specific and common guidelines, since each type presents unique nuances and characteristics. For this reason, in future work we aim to analyze and detail the reviewed studies individually, focusing on the similarities according to the type of ED, specifically AN, BN, and BED.

Along the same lines, this also makes it difficult to determine the specific characteristics that PE should have for this population. It has been shown that structured PE programs—including aerobic endurance, muscle strength, strength-endurance, or yoga exercises—significantly improve symptomatology. In general terms, the interventions that have improved the physical or mental symptomatology of individuals diagnosed with EDs are based on the use of light to moderate loads, both for strength and for aerobic endurance, progressively increased while respecting the principle of individualization.

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Determinants of Body Image in Dance Practitioners: A Cross-Sectional Study

Natalia Fraga-Pena¹  & Marta Bobo-Arce¹ 

¹ University of A Coruña (Spain).

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*Corresponding author:

Natalia Fraga-Pena
natalia.fragap@udc.es

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Short track athlete in
mid-turn, with maximum
speed and focus on the ice.
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Abstract

Body image is the mental representation an individual makes about their body. Dance is an artistic and morphokinetic practice, so aesthetics has great relevance in it. However, this aesthetic differs between dance styles. The present cross-sectional study aimed to identify the variables most significantly affecting body image among dance practitioners, including both professional and non-professional dancers. The sample was gathered by contacting the Galician Choreographic Centre, dance conservatories and dance companies from Galicia, as well as dance schools, academies, and cultural associations with dance activities in the province of A Coruña. Participants were required to complete an online questionnaire assessing body image, and individual and sociocultural data. Body image was evaluated using the Spanish version of the Body Appreciation Scale-2 and Stunkard Scale. In total, the sample included 527 adult dancers, the vast majority of whom were non-professional. The findings revealed that body mass index, body-related messages on social media, and receiving negative body-related comments, along with dieting and body transformations, had the most significant negative impact on dancers' body image. On the other hand, receiving positive comments about the body had a significant and positive influence on body image. Additionally, variables such as dance style, sexual orientation, psychological issues, and the practice of other physical activities were also identified as significant contributors.

Keywords: body appreciation, body image, body perception, body satisfaction, dance

Introduction

Body image is the mental representation that an individual forms of their own body, including attitudes and self-perceptions regarding their appearance (Cash, 2012). Appearance in general—and body image in particular—have become determining factors in contemporary Western societies (Cash, 2012). Numerous studies have analyzed the effects of different variables on body image.

On the one hand, there are sociocultural variables such as gender (Aimé et al., 2020), ethnicity and country of origin (Fallon et al., 2014), sexuality (Alleva et al., 2018), economic status, and professional, financial, and academic success (Aimé et al., 2020; Jiménez Boraita et al., 2021). Additionally, environmental influences such as social opinions and social media (Dogan et al., 2018; Heidelberger & Smith, 2018), factors related to diet (Requena-Pérez et al., 2015), and physical activity (Bibiloni et al., 2017; Hartman-Munick et al., 2020) also play a role.

At the individual level, there is a set of variables, such as age (Bibiloni et al., 2017; Swami et al., 2014), personality traits (Ferreira et al., 2018; Wade & Tiggemann, 2013), mental health (Linardon et al., 2022), bodily changes and functionality (Halliwell, 2015), and anthropometric variables such as BMI (Bibiloni et al., 2017; Dogan et al., 2018; Jiménez Boraita et al., 2021) and body fat percentage (Çatikkaş, 2011) which affect to body image.

Parallel to existing beauty standards in societies, which are influenced by diverse cultures, elite sport disciplines are also typically associated with specific body types. Dance, specifically, is an artistic and morphokinetic practice in which body forms and movement serve as objectives, making aesthetics a fundamental component (Mateu Serra & Coelho Bortoleto, 2011; Serre, 1984). The exposure of the body and continuous self-observation in mirrors amplify the focus on physical appearance and body aesthetics compared with other physical practices. Dance serves as a language that contributes to the construction of a dancer's body image through their sensations and interactions with the environment (Requena-Pérez et al., 2015). Numerous studies have analyzed body image among professional dancers across different dance styles, yielding varying results. The influence of aesthetics associated with various dance styles—ballet, contemporary dance, urban dance, ballroom dance, and others—is evident.

For example, several studies have reported that professional ballet dancers express dissatisfaction with

their body image, either because they perceive themselves as weighing too much or because they desire a thinner physique, despite having a normal body mass index (Fonseca da Cunha & Messias Machado, 2019; Neves Simas et al., 2019; Santo André et al., 2022). The pressure to maintain an extremely thin body may negatively affect dancers' body image.

Regarding individuals who practice different dance styles for non-professional reasons, the impact of dance on body image appears to differ from the previously mentioned findings. It has been observed that advanced contemporary dancers exhibit both greater body appreciation and greater body dissatisfaction compared to beginners (Halliwell, 2015).

The social relevance of this research lies in the issue of body image—the way we perceive our bodies—due to its impact on well-being. Today, numerous body image-related problems can be observed, affecting individuals' self-esteem across various contexts, although some groups experience these issues more frequently. Furthermore, the presence of body image concerns may be linked to eating disorders. Dance, as an artistic practice with a morphokinetic nature, is directly related to body image and self-perception.

From a scientific perspective, there is a lack of comprehensive compilation and in-depth study of the variables that may influence body image in the general population and, more specifically, in dancers. Moreover, while numerous interventions involving different dance modalities have shown that dance can help improve body image, it has also been observed that dancers face body image challenges due to highly demanding and rigid physical standards.

Therefore, the purpose of this study was to identify the sociocultural and individual variables that most strongly affect body image in professional and non-professional dancers, to what extent, and whether this impact on body image is positive or negative.

Methodology

Ethical approval for the study procedures and methods was granted by Ethics Committee for Research and Teaching of the Universidade da Coruña (CEID-UDC), in compliance with the University Code of Research Ethics and UDC Guide to Good Research Practice (record number: 2023-014).

Participants

The target group included professional and non-professional adult dancers who practiced any dance style. Pro-dancers were defined as those who self-identified as professionals, spent more than 20 hours per week dancing (corresponding to part-time work), belonged to a dance company or received a salary for this activity, competed, or were dance conservatory students at a professional or advanced level. Non-professional dancers included those who practiced dance for other purposes and did not meet the criteria for being considered professionals. Minors were excluded from the study.

Participants were recruited by contacting, via email and/or telephone, dance companies and professional dance conservatories in Galicia, as well as all dance schools, academies and cultural or neighborhood associations that offered dance instructions or had dance groups in the province of A Coruña. The search for non-professional participants was limited to this province because the number of potential contacts was too large to manage. To collect their names and contact information, a database was created from 23rd November 2023 to 29th February 2024.

Materials and Instruments. Procedure

Information about the purpose and utility of the research, as well as all data handling procedures and participant's rights, was provided prior to participation as part of the informed consent process. Any person who met the inclusion criteria and fulfilled the questionnaire from 5th March 2024 to 30th April 2024 was included in the sample.

The study was aimed at reaching a sample size of 400 dancers, including professional and non-professional ones, as in the Spanish validation study of Body Appreciation Scale- 2 (Swami et al., 2017) which used a sample of 400 participants in each half of the study.

Participants completed a background questionnaire, which included information on demographic and socioeconomic factors, physical characteristics, dance-related aspects, psychological and behavioral factors, body image and external influences, and health and lifestyle choices.

Moreover, to assess body image, and based on the results of a previous systematic review about instruments in body image and dance literature (Fraga-Pena & Bobo-Arce, 2025), two instruments were used: the Stunkard Silhouette Scale (Stunkard et al., 1983), to ask which

silhouette best represented participants' bodies and which one they wished to have, and to calculate the difference between these perceptions to assess body satisfaction; and the Body Appreciation Scale-2 (BAS-2; Tylka & Wood-Barcalow, 2015), translated and validated into Spanish (Swami et al., 2017), which demonstrated adequate internal consistency for both women (Cronbach $\alpha = .90$, 95% IC = .88-.92) and men (Cronbach $\alpha = .91$, 95% IC = .89-.93).

Prior to its application, the questionnaire was reviewed by an expert committee in the field of body and gender. For the data collection, Microsoft Forms platform was used for its simplicity and accessibility.

Data Analysis

For the statistical analysis, the IBM SPSS version 29 program, licensed by the Universidade da Coruña, was used. Data was coded and open-ended questions were categorized for analysis. BMI was calculated from body mass and height data. Regarding dependent variables, the absolute difference between perceived and desired silhouette, and BAS-2 average body appreciation results were calculated.

To perform inferential analysis, all variables with multiple-choice options, and the final statements regarding the relationship between the body and dance, were transformed into dummy variables. To examine the most influential variables on body image, two multiple lineal regressions were performed, taking the absolute difference in Stunkard results and the average BAS-2 score as dependent variables. Univariate analyses were also performed to obtain robust standard errors when homoscedasticity assumption was not met in linear regressions.

The same analyses were conducted dividing the sample into two groups—professional and non-professional dancers—to search for differences in the variables relevant to body image within each group. Logistic regressions were also performed for each of the statements participants were asked about.

To check whether there were any differences in the body image results, as well as in BMI, weekly dance hours, and weekly physical activity hours, between professional and non-professional dancers, a comparison of means was performed.

Results

In total, 527 answers were gathered. Table 1 shows the principal characteristics of the sample.

Table 1
Characteristics of the Sample

Variable	Mean ± SD
Age	37.4±13.2
BMI	24.0±4.3
	<i>n (%)</i>
Gender	
Women	445 (84.4)
Men	75 (14.2)
Other genders	5 (0.9)
Rather not answer	2 (0.4)
Most common characteristics	
White	501 (95.1)
Heterosexual	422 (80.1)
Finished university studies	317 (60.2)
From rural area	310 (58.8)
< €12,000/year income	187 (35.5)
Other characteristics	
Very perfectionist	236 (44.8)
Diagnosed psychological disorder	49 (9.3)
Physical disability	20 (3.8)
Undergone drastic physical change	220 (41.7)
Following a diet	93 (17.6)
Dieting > 1 year	60 (11.4)
Reasons for physical change	
Health	99 (18.8)
Physiological	59 (11.2)
Family	41 (7.8)
Work	28 (5.3)
Other reasons	42 (8.0)
No response / Don't know	8 (1.5)
Reasons for dieting	
Health	28 (5.3)
Illness	23 (4.4)
Aesthetic	22 (4.2)
Control	19 (3.6)
Ethics	9 (1.7)

Regarding dance style, the most popular category was traditional and folkloric dances, among both professional (47.7%) and non-professional dancers (61.0%). Table 2 shows the results for dance practice.

Table 2
Professional Status, Dance Style, Other Physical Activities and Weekly Practice Hours

Variable	<i>n (%)</i>
Professional dancers	
Professional	107 (20.3)
Non-professional	420 (79.7)
Dance style	
Traditional and folkloric dances	307 (58.3)
Modern and contemporary dances	125 (23.7)
Latin dances	96 (18.2)
Ballet and classical dance	53 (10.1)
Street dance	45 (8.5)
DanceSport	23 (4.4)
Fitness / acrobatic dances	10 (1.9)
Oriental dances	8 (1.5)
Afro dances	8 (1.5)
Ballroom / swing	6 (1.1)
Other physical activities	320 (60.7)
Wellness physical activity	270 (51.2)
Individual sports	77 (14.6)
Team sports	14 (2.7)
	Mean ± SD
Dance time*** (h/week)	
Professional	12.2±10.3
Non-professional	3.1±3.4
Physical activity time*** (h/week)	
Professional	3.6±4.9
Non-professional	2.8±3.5

***T-test showed statistical differences ($p < .05$) in both dance and physical activity time between professional and non-professional dancers.

Regarding comments on physical appearance, the majority of participants reported rarely receiving negative ones, while almost half reported often receiving positive ones. Additionally, most of them reported seeing pictures or messages about the ideal body in mass media or on social media either often or very frequently. Table 3 shows the results for the frequency of comments and pictures or messages about the ideal body, as well as the sources of these comments.

Table 3
Frequency of Comments, and Pictures or Messages About the Ideal Body. Sources of Comments About the Body

	Never	Rarely	Often	Very frequently		
Negative	196 (37.2%)	283 (53.7%)	44 (8.3%)	4 (0.8%)		
Positive	29 (5.5%)	192 (36.4%)	256 (48.6%)	50 (9.5%)		
Mass media	15 (2.8%)	52 (9.9%)	200 (28.0%)	260 (59.3%)		
Social media	19 (3.6%)	42 (8.0%)	170 (32.3%)	296 (56.2%)		
	Couple	Relatives	Friends	Work/Class Mates	Other known	Unknown
Negative	11 (2.1%)	129 (24.5%)	32 (6.1%)	28 (5.3%)	127 (24.1%)	95 (18%)
Positive	211 (40%)	241 (45.7%)	314 (59.6%)	130 (24.7%)	128 (24.3%)	44 (8.3%)

Stunkard Silhouettes

Participants reported, on average, a low difference between perceived and desired silhouette ($\bar{x} = 0.98$; $SD = 0.91$), ranging from 0 to 4 out of a maximum of 6, which was observed in both professional ($\bar{x} = 0.84$; $SD = 0.90$) and non-professional dancers ($\bar{x} = 1.02$; $SD = 0.91$).

As the initial regressions did not meet the assumption of homoscedasticity, Table 4 shows a list of the variables that were identified as statistically significant after re-estimating robust standard errors. In the general sample, the relevance of the variables was assessed based on confidence intervals, as SPSS did not provide p -values when applying robust standard errors due to the extreme precision of the model. The models met the assumptions of linearity for both the general ($F = 25,511$; $p < .001$) and professional samples ($F = 32,140$; $p < .001$);

independence of residues with Durbin-Watson values close to 2 in all cases, normality of residuals and non-collinearity ($VIF < 10$; tolerance > 0.1 in all cases). ANOVA showed that the models were significant, showing $R^2 = .308$ for the general sample, and $R^2 = .280$ for non-professional dancers, which means the associations were adequate. Regarding professional sample, none of the variables was pointed out as statistically significant after re-estimating robust standard errors.

Normality tests showed that neither professional nor non-professional groups followed a normal distribution regarding Stunkard difference results ($p < .001$ in both cases), therefore, the Mann-Whitney U test was used to compare means. The null hypothesis was rejected ($p = .050$), indicating that there is enough evidence to conclude that there is a significant mean difference between the groups.

Table 4
Variables That Most Affect Body Satisfaction in General Sample and Non-Professional Dancers, Statistical Significance and Confidence Intervals

	General sample			Non-professionals		
	β	p	95% CI	β	p	95% CI
BMI	.094	<.001	[.094, .094]	.095	<.001	[.064, .126]
Asexuality	2.284	<.001	[2.284, 2.284]			
Frequent negative comments about body	.439	<.001	[.439, .439]	.543	.005	[.161, .925]
Rare positive comments about body	.218	<.001	[.218, .218]			
Positive comments about body from strangers				-.290	.036	[-.561, -.020]
Frequent exposure to ideal body images/ messages on social media	-.214	<.001	[-.214, -.214]	-.219	.013	[-.391, -.047]
Dieting for ethical reasons	-.802	<.001	[-.802, -.802]			
Unspecified reasons for physical change	.364	<.001	[.364, .364]			
Diagnosed personality disorder	1.743	<.001	[1.743, 1.743]			
Team sport	-.591	<.001	[-.591, -.591]	-.641	.001	[-1.004, -.279]

Table 5

Variables That Most Affect Body Appreciation in General Sample, Professional Dancers and Non-Professional Dancers, and Statistical Significance

	General sample			Non-professionals		
	β	p	95% CI	β	p	95% CI
BMI	-0.034	<.001	[-.050, -.017]	-0.040	<.001	[-.058, -.022]
Maximum primary education	-1.379	<.001	[-2.078, -0.681]	-1.167	.001	[-1.879, -.456]
€24,000-32,000 per year	0.228	.008	[.061, .396]	0.244	.010	[.059, .430]
Diagnosed psychological disorder	-.314	.004	[-.526, -.102]	-0.419	<.001	[-.650, -.188]
Prefer not to answer about psychological disorder	-0.488	.003	[-.814, -.161]	-0.707	<.001	[-1.087, -.327]
Physical disability				0.450	.019	[.075, .825]
Never negative comments about body	0.301	<.001	[.171, .431]	0.241	.001	[.095, .388]
Frequent negative comments about body	-0.364	.003	[-.607, -.122]	-0.437	.002	[-.711, -.163]
Negative comments about body from work or classmates	0.307	.034	[.022, .591]			
Frequent positive comments about body	0.275	<.001	[.144, .406]	0.250	.001	[.102, .398]
Very frequent positive comments about body	0.579	<.001	[.360, .799]	0.542	<.001	[.284, .800]
Never viewing pictures/messages in traditional media about body	-0.481	.011	[-.850, -.113]			
Frequent viewing of pictures/messages on social media about ideal body				0.197	.009	[.050, .344]
Very frequent viewing of pictures/messages on social media about ideal body	-0.256	<.001	[-.379, -.132]			
Aesthetic reason for dieting	-0.670	<.001	[-.977, -.364]	-0.833	<.001	[-1.248, -.417]
Control reasons for dieting	-0.542	.001	[-.865, -.219]	-0.674	.002	[-1.103, -.245]
1-6 months diet				0.419	.046	[.007, .831]
Unspecified reasons for physical change	-0.364	.001	[-.587, -.141]			
Oriental dances	-1.005	<.001	[-1.507, -.502]			
Ballroom/swing dance	0.606	.035	[.042, 1.171]	0.717	.014	[.143, 1.291]
Wellness physical activity	0.134	.031	[.012, .256]			

BAS-2

Participants reported, on average, a moderate appreciation of body image ($\bar{x} = 3.56$; $SD = 0.85$), on a scale ranging from 1 (minimum) to 5 (maximum). When divided into professional ($\bar{x} = 3.54$; $SD = 0.86$) and non-professional dancers ($\bar{x} = 3.57$; $SD = 0.85$), the scores were similar.

Table 5 shows a list of the variables that were brought to the front after regression. The models met the assumptions of linearity for both the general ($F = 14.94$; $p < .001$), and non-professional samples ($F = 13.90$; $p < .001$); independence of residuals, with Durbin-Watson values close to 2 in all cases, normality of residuals, and non-collinearity ($VIF < 10$; tolerance > 0.1 in all cases). The homoscedasticity assumption

was not met in the professional sample regression, and none of the variables was pointed out as statistically significant after re-estimation using robust standard errors. ANOVA showed that the models were significant, with R^2 of .361 (general sample), and .340 (non-professional dancers), indicating that the associations were adequate.

Normality tests showed that neither professional nor non-professional groups followed a normal distribution regarding Stunkard comparison results ($p = .031$ and $p = .001$, respectively), therefore, the Mann-Whitney U test was used to compare means. The null hypothesis was accepted ($p = .763$), indicating that there is not enough evidence to conclude that there is a significant mean difference between groups.

Statements

Most participants (68.3%) agreed that dance made them feel more and better connected with their bodies. Additionally, 36.1% answered that improving their dance technique made them value their bodies more; 14.2% reported feeling more pressure on their bodies when dancing in a group; 13.5% answered that if they did not practice dance, they felt uncomfortable with their bodies; and 22.2% answered that they did not identify with any of the previous statements. Percentages were higher among professional dancers than non-professional ones for each of the first four statements.

Multiple logistic regression was performed for each of the five statements. In none of the cases was pseudo- R^2 higher than .3, indicating a weak fit of the models.

Discussion

This study investigated the variables that have the greatest effect on body image in professional and non-professional dancers, aiming to identify them, determine the extent to which they affect body image, and understand how they correlate.

The main finding was that, in general, body mass index, comments about the body and social media, and dieting and body changes variables have the greatest effect on the body image of dancers. Other relevant factors were dance style, asexuality, psychological issues, or other physical activity practices (whether they practice and type). Some differences were found between professional and non-professional dancers regarding the variables with the greatest effect.

Body Mass Index

The current study found body mass index to be the most relevant variable affecting body image in both professional and non-professional dancers. These results showed that higher BMI is linked to lower body appreciation and greater discrepancy between ideal and perceived body. Some studies had already identified BMI as a relevant variable for body image in dancers (Fonseca da Cunha & Messias Machado, 2019). However, others have not found it to be a meaningful predictor of body satisfaction (Boyes & Cornelissen, 2024).

Comments About the Body and Social Media

In general, never or rarely receiving negative comments about their bodies, or receiving positive comments about them very frequently or often, had a positive effect on body satisfaction and body appreciation. Conversely, rarely or never receiving positive comments about their bodies, frequently receiving negative comments about them, and

very often viewing pictures or messages about the ideal body on social media, had a negative effect on body satisfaction and body appreciation. These results supported the findings of Halliwell (2015), where social media was identified as an influential factor on body image. However, contrary to the findings of Dogan et al. (2018) and Heidelberger & Smith (2018) with adolescent population, the sender of these messages was not found to be significant after the regressions.

Some confusing results were also found. In the general sample, whether the negative comments were made by classmates or workmates was also related to a better body appreciation. Likewise, never viewing pictures or messages about the ideal body in traditional media was associated with worse body appreciation. These findings might indicate that participants do not care about comments and opinions from their classmates or workmates, or that dancers perceived these body-related comments as constructive. Regarding traditional media, the fact that participants may not watch it or consciously avoid it to prevent exposure to beauty standards might explain these results.

Diet, Body Changes and Body Functionality

In general, following a diet for aesthetic or control reasons, and having undergone a drastic body change for reasons other than those specified, were related to worse body satisfaction and body appreciation. However, dieting for ethical reasons was positively related to body satisfaction in the general sample. Santo André et al. (2022) also linked restrictive diets aimed at achieving leaner bodies to body dissatisfaction in ballet dancers.

On the other hand, contrary to the findings of Argyrides et al. (2023) in non-dancers, having any physical disability was positively related to a better body appreciation in non-professional dancers. This finding might also be explained by the fact that dancers with any physical disability may appreciate their bodies more for what they are able to do than for what they are not.

Dance Practice

When it comes to dance styles, some disciplines were shown to be relevant to body image. BAS-2 results showed that practicing oriental dances has a detrimental effect on body appreciation, while other disciplines, such as ballroom dance or swing dance, had a positive impact, with similar results in non-professional dancers.

Nevertheless, the results contradict those of Tiggemann et al. (2014) and Walter (2020), in which practitioners of belly dance, an oriental dance, reported better body image results and less body dissatisfaction than non-dancers. Additionally, some interventions involving belly dance with

women diagnosed with breast cancer showed improvements in body image (Boing et al., 2023; Denig et al., 2022). The exposure of the body in this type of dance might explain the low body appreciation levels found in the present study. However, the disagreement with the literature may come from the different characteristics of the samples, as belly dance helped women with breast cancer to regain appreciation of the sensuality and sexual attractiveness of their bodies.

Additionally, in literature, ballet dancers have been shown to experience body image issues, such as moderate-to-severe alterations in body image perception (Da Silva et al., 2016), and body dissatisfaction (Fonseca da Cunha & Messias Machado, 2019; Granha Vasconcellos et al., 2021). However, our results did not find ballet practice to be a meaningful predictor of body image, even though ballet aesthetic standards are deeply rooted.

Concerning professional status, it was expected to be relevant to body image, as professional dancers expose their bodies to a larger audience and their image is an essential part of their career. Despite this, our findings did not find professional status in dance to be significantly relevant to body image. The fact that only 12 out of the 107 professional dancers practiced ballet might explain this discrepancy, as literature has mainly focused on ballet practitioners when it comes to professional dancers (Fonseca da Cunha & Messias Machado, 2019; Granha Vasconcellos et al., 2021).

Psychological Disorder

People who reported having any psychological disorder showed worse body appreciation. Literature has already established that psychopathologies such as depression and anxiety are inversely associated with body appreciation (Linardon et al., 2022).

Other Physical Activities

Practicing team sports was reported to have a positive relationship with body image. Body appreciation was also positively related with practicing activities related to wellness and health. Hartman-Munick et al. (2020) explained that, although sport practice might have a positive impact on mental and physical health, it is important to acknowledge its influence on body image, especially in activities that traditionally encourage certain body types or sizes. Likewise, organized and team sport practice has been associated with positive body image (Vaquero-Cristóbal et al., 2013).

Socioeconomical Variables

Even though evidence has previously supported the relationship between gender and body image (Aimé et

al., 2020), the present results did not find any significant relationship. Likewise, age was not related to body image, even though some studies have suggested that maturity might help women accept body changes and, therefore, result in higher body satisfaction in adulthood (Swami et al., 2014). Other studies have indicated that, because feminine beauty standards tend to favor younger bodies, body image might be more positive in younger women than in middle-aged and older women (Bibili et al., 2017).

Concerning sexual orientation, asexuality was related to a greater discrepancy between desired and perceived body, consistent with the findings of Swami et al. (2019). Asexual dancers might be especially dissatisfied with their bodies while trying to fit into heteronormative societies.

Finally, concurring with Aimé et al. (2020), achieving primary or elementary school as the highest academic level, and earning between €24,000 and-32,000 per year were also identified as relevant for body image, negatively and positively, respectively. These are classical indicators of social success, and might impact body image, as bodies can also be understood as a status symbol, playing a role in the identity construction and social value of individuals.

Limitations and Strengths

These findings need to be considered in light of some limitations. Firstly, regarding the sample, our target group was limited to adults who danced in Galicia, so the findings cannot be generalized to younger populations, who deal with body image differently, or to other regions, as folk tradition plays a significant role in dance. The large number of institutions offering dance lessons made it unfeasible to manage recruitment across the entire region, so the recruitment of non-professional dancers was focused on A Coruña province.

Secondly, concerning the assessment of body image, even though two validated tools were used, Stunkard scale offers a dichotomous view of genders and bodies, so it might not represent everyone. Additionally, the online questionnaire might have limited access for older adults who are less familiar with technology.

Finally, some regressions did not meet the assumption of homoscedasticity, so robust standard errors were computed to obtain more reliable estimates.

Although certain limitations were identified, the strengths of this study provide a strong foundation for the conclusions drawn. These include the anonymity of the sample collection, a simple and quick questionnaire accessible to anyone with minimal technological skills, a large sample size, the coverage of multiple variables—including the professionalization of dance, which is an innovative approach—and the rigorous analysis of variables.

Likewise, the relevance of the topic must be highlighted: this study provides new findings in the field of body image and dance, which might contribute to improving the wellbeing of dancers. It also raises awareness of a contemporary topic, namely body image, especially in fields with highly labelled aesthetic standards such as dance.

Future Research

Further studies should explore body image in dancers from a qualitative perspective to comprehensively grasp the intricacies of a complex concept like body image, focusing on the most crucial factors. Future research should also include cross-sectional and longitudinal studies with diverse populations across various age groups and geographical locations. Intervention studies on the body image of non-dancers following participation in a specific dance style program are also convenient.

Conclusions

The present study found that body mass index, messages about the body on social media, and comments about the body, as well as dieting and body change variables, have the greatest effect on the body image of professional and non-professional dancers. Additional factors, such as dance style, asexuality, psychological issues, and the practice of other physical activities, were also identified as relevant. These findings contribute not only to the knowledge of body image in dancers, but also to a greater understanding of the importance of context and other variables in this research area.

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Validation of the DICAT Instrument for Assessing Motor Creativity in Dance Improvisation Tasks

Elena Pérez-Calzado^{1*} , Cristina Calvo-Estelrich² , Carlota Torrents¹  & Javier Coterón² 

¹ Faculty of Physical Education and Sport Sciences (INEF), Polytechnic University of Madrid (Spain).

² National Institute of Physical Education of Catalonia (INEFC), University of Lleida (Spain).



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*Corresponding author:

Elena Pérez-Calzado
perezcalzado@gmail.com

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Short track athlete in
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Abstract

This study aimed to design and validate the Dance and Improvisation Creativity Assessment Tool (DICAT), an instrument to subjectively assess movement creativity in dance improvisation tasks performed by individuals without any specific dance training. The research was conducted to evaluate components of creativity in dance for which, to date, there is no specific instrument. We created an instrument to allow users to analyze both quantitative and qualitative aspects, addressing the dimensions of fluency, flexibility, originality, elaboration, and aesthetics. The instrument development and validation occurred across four phases: (a) initial design based on a literature review, (b) validation of the content by a panel of experts, (c) analysis of inter-observer reliability using the weighted kappa coefficient, and (d) criterion validation calculating the correlation with external measurements of motor skills diversity. The results show substantial validity, which indicated high reliability and consistency with external criteria. The DICAT is an innovative, valid, and reliable instrument for evaluating motor creativity in improvisation, offering a comprehensive approach suited to the specific characteristics of this field. This instrument has important applications in both research and education, offering a methodology that can be replicated and adapted to diverse contexts that promote creativity through movement.

Keywords: aesthetics, elaboration, inexpert, innovation, motor creativity, originality

Introduction

Guilford (1950) defined creativity as an ability to practice divergent thinking, an essential pillar in human development that is characterized by the production of original, innovative, and useful ideas. He differentiated between creativity and conventional intelligence, opening a line of research focused on divergent thinking as a process aimed at searching for innovative solutions (Runco, 2004).

Motor creativity, understood as an individual's ability to respond in an appropriate, diverse, original, and unique way to a motor skills-based situation or problem (Murcia, 2001), constitutes a field of study of growing relevance within the Physical Activity and Sports Sciences. This ability to generate novel and adaptive motor responses is also a key performance factor in sports. Its study is particularly relevant in sports context where interaction with the environment and decision-making time play a decisive role in skill development and in problem solving, as well as in creative-expressive disciplines (Araújo et al., 2006).

There are multiple creativity evaluation tests that analyze the ability to generate ideas, such as the Remote Associates Test (RAT; Mednick, 1962), the Consensual Assessment Technique (CAT; Amabile, 1982), or the Runco Ideational Behavior Scale (RIBS; Runco et al., 2001). One of the most common is the Tests of Creative Thinking (TTCT) created by Torrance (1966). This assess four dimensions of creativity: fluidity, understood as the ability to generate multiple responses to the same problem; flexibility, associated with the diversity of the solutions or ideas produced; originality, which evaluates the ability to produce innovative and unconventional ideas; and elaboration, which involves the amount of detail, complexity, and development of the ideas. These dimensions have been used as the theoretical research foundation in the Physical Activity and Sports Sciences field, with the main objective of assessing motor creativity in different disciplines (Canton et al., 2020). Specifically, this research has focused on studying the exploratory behavior of the individual (Hristovski et al., 2011), defined as the diversity and variability of their motor actions—understood as movement with a specific aim (for examples of the concept of motor actions, see the Annex)—produced by a complex system in a dynamic setting. On the other hand, Richard et al. (2020) developed the PLAY Creativity instrument for assessing motor creativity in children from grades 4 to 6 by measuring the following variables: fluency, originality/ imagination, appropriateness, and flow.

In addition to specific tests, some sports research assesses the components of creativity in real-life settings. The following are some of the methods used to analyze variables of motor creativity taking into account the complexity of the system behavior: (a) Multiscale Entropy Measures (MSE), which assess the variability of the behavior; (b) Dynamic Overlap, which assesses the fluency and flexibility of motor behavior; and (c) Tucker's congruence coefficient, which evaluates the level of similarity between patterns and provides information about their originality (see Canton et al., 2022).

These methods have also been used to analyze motor creativity and exploratory behavior during dance improvisation tasks (Aragónés et al., 2021; Pérez-Calzado et al., 2024; Torrents et al., 2010). In the creative-expressive dance context, improvisation tasks represent the ideal setting to stimulate creativity and divergent thinking (Blom and Chaplin, 1988) and allow individuals to explore novel and spontaneous solutions during unpredictable situations, thus facilitating a continuous and inseparable interaction between the environment, the body, and the mind (Richard et al., 2021). This process stimulates not only the production of original movements, but also motor adaptability, which has emerged as a key element for enhancing creativity (Lewis and Lovatt, 2013).

All of the aforementioned research used observational instruments with categories (e.g., moving through space, levels, actions performed with the body, etc.) and subcategories (e.g. the "moving through space" category is subdivided into walking, running, crawling, rolling, etc.) that are specific to the field of dance. This makes it possible to quantify the number and types of motor patterns that a person performs during an improvised dance.

While these instruments have been useful for analyzing quantitative aspects, such as motor fluency or diversity, they do not fully capture the richness and depth of the creative process, which involves subjective variables. For example, originality, elaboration (difficulty level of the proposed movement), or aesthetics (ability of the performer to create visual and emotional impact on the spectator through expressiveness, coherence, and harmony among the sequences), (Coterón et al., 2008) are key aspects of creativity that cannot be assessed solely using quantitative criteria. Though prior research has shown that objective kinematic parameters significantly influence aesthetic perception (Torrents et al., 2013), and consequently the assessment of motor creativity, other aspects such as the quality of the movement cannot be systemically quantified.

In this regard, specific tests have been created to evaluate motor creativity in dance using subjective variables. Brennan (1982) designed the Creative Movement Composition Test based on the Structure of Intellect by Guilford (1957), which consists of three components: operations, contents, and products. Brennan developed three tests based on those components: a) Position Tests, which evaluates originality, with an 8-item checklist for body positions; b) Composition Test, which measures the number of original movements performed by a person during the construction of a sequence based on four pre-established body positions; and c) Improvisation Test, which evaluates the number of new movements the person performs during an improvised dance with the constraint of keeping one foot on the ground. The research was conducted with 60 college dance students who had received less than one semester of training. Both this test and the TTCT (Torrance, 1966), considered a benchmark in overall creativity evaluation, have contributed significantly to the development of instruments for analyzing both creative thinking and creative expression, including their application in the field of movement. On the other hand, Pürgstaller (2020) validated the Creativity in Dance Test (CDT), analyzing the fluency, flexibility, and originality of movements in children from grades 3 to 6.

Some research has also used previously validated tests to evaluate creativity in the field of dance. For example, Clements et al. (2018) used the CAT instrument (Amabile, 1982) to analyze overall motor creativity (without distinguishing specific variables) in choreography interpreted by contemporary dance students.

Other instruments evaluate creativity in other creative-expressive arts, such as Body Language. In this case, Aranguren and Irrazabal (2012) designed the Evaluation of Creativity Behavior (ECC by its Spanish acronym) across different areas, including the Body Language area which includes the dance and theater disciplines. The ECC assesses creativity through items (e.g., “has performed a dance choreography” or “has attended dance classes”) based on the number of times (Never, Once or Twice, Sometimes, Often, Very Often) a person performed said actions throughout their life. On the other hand, Méndez-Martínez and Fernández-Río (2019) validated the *Instrument to Measure Motor Creativity* (ICM). In this case, the ICM assessed the motor creativity in adolescents during a Body Language task, bearing in mind the variables of fluency, flexibility, imagination, and originality.

Considering the above, an instrument needs to be developed for the rigorous and comprehensive assessment of motor creativity in dance, which takes into account subjective variables such as elaboration and aesthetics that have not been addressed in the previously discussed instruments. These qualitative variables require subjective evaluation based on expert opinion and perception, as experts notice expressive and aesthetic nuances that elude quantitative measurements (tallies, measurements, etc.) Unlike objective evaluations, subjective evaluation allows for a more holistic and contextual interpretation of motor creativity. Additionally, we found no other validated instruments for evaluating motor creativity in adults without specific dance training, which highlights the need to develop an adequate instrument for this. Therefore, the aim of this study was to design and validate an instrument for the subjective assessment of creativity to facilitate the observation of improvised motor actions performed by individuals without specific dance training and to assess their level of creativity according to the variables of fluency, flexibility, originality, elaboration, and aesthetics. This instrument seeks to overcome current challenges and provides a precise and replicable methodology, contributing to enriching both arts research and educational programs that promote creativity through movement.

Methodology

Participants

We contacted professionals to join the panel of experts for the design and validation of the Dance and Improvisation Creativity Assessment Tool (DICAT). The established inclusion criteria were as follows: a) university professors; b) who conduct research in the field of creativity, dance, and Body Language; c) with at least 10 years of experience. Finally, seven experts collaborated (five women and two men) who were university professors with over 20 years of experience in the field of creativity, dance, and Body Language. Together with the principal investigators, they offered their knowledge during the first phase of the instrument's evaluation. All the experts signed an informed consent form to participate in the study. The Catalan Sports Administration Clinical Research Ethics Committee (09-2018-CEICGC) approved the study.

Table 1
Items and open-ended questions comprising the DICAT

Item or open-ended question	Description
Fluency item	Number of motor actions* performed by the person.
Flexibility item - a	Diversity of the motor actions the person completes, bearing in mind the use of different categories (displacements through space, spins or turns in the three axes of space, jumps, balances, level changes, etc.).
Flexibility item - b	Diversity of the motor actions performed by the person, considering the differences between them, even if they are in the same category (use of different body parts, different rhythms, different movement qualities, etc.).
Originality item	Uncommon, new, or unique movements by the person.
Elaboration item	Actions with a certain level of complexity in terms of construction and/or performance.
Aesthetics item	Artistic value of the composition, degree of sensory and emotional impact generated on the viewer.
Open-ended question - a	If you consider that an original action has been performed, describe it and explain why it is considered original.
Open-ended question - b	From your perspective, evaluate the creative and artistic quality of the improvisation, explaining in as much detail as possible what brought you to that conclusion.

Nota. *Body movement with a specific objective. E.g., if a person walks while moving their head, crouches down, and performs a somersault at a low level, they are deemed to have performed three motor actions: displacement through space, a change in level, and a spin.

Instrument Design

The DICAT was designed using IBM Excel software (version 2411). Considering the five creativity variables we aimed to measure (fluency, flexibility, originality, elaboration, and aesthetics), we created five items to be evaluated on a 5-point Likert scale, where 1 = “very little” and 5 = “a lot.” Similarly, to explore in-depth the subjective assessment of the observer and supplement the quantitative assessment, we decided to include two open-ended questions. Both the items and the open-ended questions can be seen in Table 1.

Instrument Validation

Criterion and content validity (Cronbach and Meehl, 1955; Messick, 1989) were considered when validating the instrument. On the one hand, the content validity is aimed at qualitatively determining whether the instrument truly measures what it was designed to measure. In this study, we sought out the opinion of experts in the field when selecting and evaluating the creativity variables. On the other hand, the criterion validity was addressed, which involved comparing the results obtained from using the assessment instrument with an external criterion that aimed to measure the same construct (Thomas & Nelson, 2007), with the goal of ensuring there were no significant differences between

both measures. In this case, we checked the correlation of the observation with quantitative data obtained from the study conducted by Pérez-Calzado et al. (2024), analyzing exploratory behavior through systematized observation of the same observation material (recordings of improvised dances by people without specific dance training).

Procedure

The instrument design and validation process took place across four phases following the procedure developed in similar research (Conejero et al., 2016; Sánchez-López et al., 2023): (a) literature review and provisional instrument design, defining five items to measure the five dimensions of creativity and two additional open-ended questions; (b) content validation based on the opinion of experts and modification of the initial version of the instrument; (c) interobserver validation of the instrument through two researchers’ observational analysis of improvised dances; and (d) criterion validation through comparison with the systematic observation.

In the first phase, we conducted a literature review of the study of creativity and research in the field of dance so as to theoretically justify the design of the instrument. We then started on the initial design of the provisional instrument.

Table 2

Coefficient of knowledge, coefficient of argumentation, and coefficient of expert competence obtained from the expert opinion

Expert	1	2	3	4	5	6	7	<i>M</i>	<i>SD</i>
<i>Kc</i>	1	.9	.9	.8	1	.9	.9	.91	.07
<i>Ka</i>	1	1	1	.9	1	1	1	.99	.04
<i>K</i>	1	.95	.95	.85	1	.95	.95	.95	.05

Nota. *Kc* = coefficient of knowledge; *Ka* = coefficient of argumentation; *K* = coefficient of expert competence; *M* = mean; *SD* = standard deviation.

In the second phase, we contacted a panel of experts and calculated the expert competence coefficient (*k*) to ensure their adequate selection. To this end, each professional was given a questionnaire containing a self-assessment of their expert competence (Cabero & Barroso, 2013) in relation to the research subject. The *k* coefficient was calculated through the semi-sum of two coefficients taken from the questionnaire: the coefficient of knowledge (*kc*), which reflects the expert's level of understanding of the research problem, and the coefficient of argumentation (*ka*) which indicates the evidence or sources the expert used to back up their opinion. The *k* coefficient is expressed as a score between 0 and 1 and divided into three levels: high ($k > .8$), medium ($k = .7-.8$), and low ($k < .7$). The final panel of experts comprised seven members who obtained a mean optimal *k* coefficient ($M = .95$; $SD = .05$; see Table 2).

After creating the panel, the experts assessed the items and open-ended questions for: (a) clarity, clear writing, and unambiguous understanding of the meaning (yes/no responses); (b) importance, level of importance, and meaningfulness of the assessed item using a 0-3 Likert scale, where 0 = lowest level of importance and 3 = highest level of importance; (c) relevance, suitability for the objective of the instrument (yes/no responses); and (d) sufficiency: is the item adequate for assessing the objective, or should it be added or eliminated? (sufficient/add/remove responses). For each item and open-ended question, there was a section for justifying the given score and for taking notes or offering relevant suggestions for improvement. The experts' assessments were considered for the modification and improvement of the instrument, thus achieving content validation.

In the third phase, the instrument's inter-observer reliability (Cohen, 1960) was calculated. To do this, two expert dance and body language researchers used the instrument to assess the creativity of twelve dance improvisations performed by individuals without any specific dance training. After observation, agreement was calculated by comparing the data through the weighted kappa (*Kw*) coefficient, an extension of Cohen's kappa designed for

evaluating the level of agreement between observers in categorical variables with a hierarchical order (Cohen, 1968). Unlike the standard Cohen's kappa, *Kw* assigns different levels of varying gravity to disagreements according to their magnitude on the scale (Cohen, 1968). Using it in this research allowed us to more precisely capture the intensity of the disagreements in the assessment of creativity in the dance improvisations, wherein the instrument scores are of an ordinal nature. This provides a nuanced perspective of the level of agreement between the raters.

In the fourth phase, we calculated the criterion validity of the instrument for the component for which objective data were already available, specifically flexibility. We compared the researchers' observations from the third phase with the systematic observation conducted in the study by Pérez-Calzado et al. (2024). This research analyzed the flexibility variable (q_{stat}) using the tool used by Aragonés et al. (2021), which was adapted from the original research by Torrents et al. (2010) and Torrents et al. (2015). This variable systematically and precisely quantifies diversity in the movement patterns (for more information see Hristovski et al., 2013).

To calculate content validity, we looked to expert opinion, as described in the procedure's second phase. Interobserver agreement was analyzed in the third phase using IBM Excel software (version 2411) to calculate the *Kw* (Cohen, 1968) coefficient. To interpret the level of agreement obtained, we used the scale proposed by Landis and Koch (1977), in which a value of less than 0 indicates "poor agreement," 0-.2 indicates "slight" agreement, .21-.40 indicates "fair," .41-.60 indicates "moderate," .61-.8 indicates "substantial" agreement, and values exceeding .81 represent "almost perfect" agreement.

Lastly, in the fourth phase of the procedure, we used Pearson's correlation to determine the criterion validity of the instrument, relating the mean ratings the researchers obtained through DICAT for the flexibility variable with the q_{stat} ratings from the systematic observation conducted by Pérez-Calzado et al. (2024).

Table 3
Results from the panel of experts for each item

Item	Clarity			Importance		Relevance			Sufficiency			
	Mode	Yes (%)	No (%)	Mean	SD	Mode	Yes (%)	No (%)	Mode	Remove (%)	Add (%)	Sufficient (%)
Item 1	1	86	14	2.57	0.53	1	100	0	2	14	29	57
Item 2a	1	86	14	2.71	0.49	1	100	0	2	0	0	100
Item 2b	1	71	29	3.00	-	1	100	0	2	0	14	86
Item 3	1	86	14	3.00	-	1	100	0	1	0	57	43
Item 4	1	57	43	2.43	0.79	1	100	0	1	0	57	43
Item 5	1	57	43	2.43	0.79	1	86	14	1	29	43	29
Open-ended question - a	1	57	43	2.29	1.11	1	86	14	2	14	14	71
Open-ended question - b	1	71	29	2.14	1.07	1	86	14	2	14	14	71

Results

The results of this research are described below according to the phases described in the study methodology.

Content Validation

The results of the content validation by the experts can be seen in Table 3. In terms of clarity, when the experts deemed the initial wording of certain items to be unclear (item 4, item 5, open-ended question - a), those items were modified. All the experts deemed both the items and the open-ended questions to be important to the study subject ($M = 2.57$; $SD = 0.60$). In terms of relevance, 100% of the experts deemed items 1 to 4 to be relevant. In addition, 86% of the experts considered item 5 and the open-ended questions to be relevant. Lastly, sufficiency data were considered to modify the number of items. The final instrument can be seen in the article annex.

Inter-Observer Reliability

Two researchers used the expert-validated version of the instrument to evaluate the improvised dances of twelve individuals without specific dance training. An optimal Kw index ($Kw = .781$) was obtained, indicating a substantial level of agreement between the two observers, very close to the level considered “almost perfect,” thereby supporting the reliability of the instrument.

Criterion Validation

Table 4 shows the researchers' scores for the observations according to the flexibility section of the DICAT, compared with the q_{stat} values from the systematic observation. The parameter q determines the structure of the behavior and its dynamic properties. q_{stat} is the stationary value obtained by analyzing the dynamics of a time series and is a measure for quantifying exploratory behavior (fluency and variability of behavior). Note that the q_{stat} values range from 0 to 1, where 0 represents a completely erratic and diverse behavior and 1 represents completely repetitive behavior. The correlation obtained between them was $-.71$, indicating a strong correlation.

Table 4
Flexibility scores in the systemic observation and with DICAT

Improvisation	q_{stat}	Flexibility
1	.355	5
2	.442	2
3	.634	1.5
4	.353	3.5
5	.344	2
6	.899	1
7	.569	2
8	.333	4
9	.550	2
10	.365	4
11	.818	2
12	.559	3

Discussion

We aimed to design and validate an instrument for the subjective assessment of creativity in dance improvisation tasks performed by individuals without specific dance training and to evaluate their level of creativity across the variables of fluency, flexibility, originality, elaboration, and aesthetics. The resulting instrument, called DICAT, allows expert observers to assess creativity in improvisational dance subjectively.

Creativity in dance has been considered from a quantitative perspective (Aragónés et al., 2021; Pérez-Calzado et al., 2024; Torrents et al., 2010), focusing on objective variables such as the number of times a movement pattern is repeated, the speed of transitions between patterns, or the diversity of patterns. However, dance specifically, and the creative-expressive disciplines in general, promote the constant generation of diverse, unique, and multi-dimensional motor actions (Castañer et al., 2009), which require tools that allow holistic analysis from a qualitative and subjective perspective.

To guarantee the content validity of the designed instrument, it was necessary to involve experts in the subject matter to stabilize the responses to each item and conduct a proper analysis of them. In this case, the seven experts' quantitative assessments were accompanied by qualitative contributions, which are considered essential for the development of an instrument (Subramanian and Silverman, 2000). These contributions were considered when modifying and perfecting the initial version of the questionnaire, with attention to the dimensions of quality, importance, relevance, and sufficiency.

In addition to content validation, interobserver reliability was calculated. In that sense, we deemed it appropriate to use the *Kw* coefficient to assess the level of disagreement among observers (Cohen, 1968). In this case, a *Kw* index of .781 was obtained, indicating good instrument reliability. This index has been used in other studies, in which values between .61 and .80 were considered "good" (Schorer and Weiß, 2007). The research results indicate that the instrument is valid and ensures optimal reliability for assessing creativity in dance improvisation performed by individuals without specific dance training.

To obtain evidence of criterion validity, we used as external criteria the results for flexibility in movement patterns from the study by Pérez-Calzado et al. (2024). In this case, there was a correlation of $-.71$, indicating a strong correlation, which supports the instrument's validity. The innovative aspect of this research is also its main limitation: the inability to validate the criterion for other studied variables (originality, elaboration, and aesthetics) due to the lack of prior research. However, DICAT has emerged as a valid and reliable tool for assessing creativity and opens the door to future research to

validate this instrument in other population groups such as experts in dance, similar arts disciplines, or in different stages of the learning process.

Conclusions

DICAT demonstrates optimal validity values, indicating that it is an effective instrument for assessing motor creativity in dance improvisation among individuals without specific dance training. This instrument allows expert observers to subjectively analyze key aspects of improvisation, such as fluency, flexibility, originality, elaboration, and aesthetics. It provides both quantitative and qualitative data, offering a comprehensive and nuanced understanding of creativity.

Validating this instrument has significant implications for both creativity research and for the field of education, as it can be used to assess creativity in training programs across various educational stages. Likewise, it establishes a methodological foundation that can be replicated and that facilitates the development of valid instruments for assessing creativity in different population groups.

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Annex

DICAT

Dance and Improvisation Creativity Assessment instrument **Instrument for evaluating dance and improvisation creativity**

Guilford (1950) defined creativity as an ability for divergent thinking that can produce innovative, useful, and unexpected ideas. With that definition in mind, Torrance (1966) developed the Tests of Creative Thinking to measure creativity and identify individuals with creative talent. These tests consider four dimensions: fluency, flexibility, originality, and elaboration.

Building on these authors' contributions, this instrument was created to facilitate the observation of improvised motor actions and to evaluate the level of creativity from the observer's subjective perspective. Motor actions are understood as movement of the body with a specific objective in mind (physical, cognitive, and/or socio-affective) within the context of dance and Body Language. For example, if a person spins, takes multiple fast steps while waving their arms, and then jumps with their arms and legs extended, they would be considered three distinct motor actions (a spin, a movement, and a jump).

The instrument comprises five components corresponding to the following dimensions: fluency, flexibility, originality, elaboration, and aesthetics. All items are measured using a Likert scale from 1 to 5, where 1 = "Very little" and 5 = "A lot."

- 1. Fluency:** the number of motor actions a person completes.
- 2. Flexibility:** the diversity of motor actions a person completes, considering the following:
 - a) use of different categories (moving through space, spins or turns in the three axes of space, jumps, balancing, level changes, etc.).
 - b) differences between them, even if they are in the same category (use of different body parts, different rhythms, distinct movement qualities, etc.).
- 3. Originality:** uncommon, new, or unexpected movements performed by a person.
- 4. Elaboration:** actions with some level of complexity in their construction and/or performance (complexity defined as the number of segments involved, the number of simultaneous actions, or the difficulty or level of expressiveness of said actions).
- 5. Aesthetics:** the artistic value of the composition, degree of sensory and emotional impact generated in the observer.

Rate the aspects listed above in the observed improvisation on a scale from 1 to 5, where 1 = "Very little" and 5 = "A lot":

	1-Very little	2	3	4	5-A lot
Fluency					
Flexibility					
Originality					
Elaboration					
Aesthetics					

Respond to the following questions:

1. If you believe an original action was performed, describe it and explain what made it original.

I observed multiple original actions...

2. From your perspective, evaluate the creative and artistic quality of the improvisation, explaining with as much detail as possible what brought you to that conclusion.



Influence of (Dis)empowering Climates on the Teaching Identity of Physical Education Pre-service Teachers

Antonio Granero-Gallegos^{1,3} , María Carrasco-Poyatos^{1,3} , José María Rubio-Valdivia¹ 
& Ginés D. López-García² 

¹ Faculty of Education, University of Almería, Almería (Spain).

² Faculty of Education, University of Murcia, Murcia (Spain).

³ Faculty of Education and Health Research Center, University of Almería, Almería, (Spain).



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*Corresponding author:

Ginés David López-García
glopez@um.es

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Short track athlete in
mid-turn, with maximum
speed and focus on the ice.
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Abstract

The aim of this study was to analyze the mediating role of academic engagement and intention to become a teacher in the relationship between (dis)empowering climates and professional teaching identity in Physical Education pre-service teachers. An observational, cross-sectional design was used. A total of 478 university students enrolled in initial Physical Education teacher education programs (44.8% women; $M_{age} = 27.09$; $SD = 6.32$) participated. Validated scales were used to assess empowering and disempowering motivational climates, academic engagement, intention to become a teacher, and professional teaching identity, and a structural equation model with latent variables was estimated. The results of the model highlight the importance of an empowering motivational climate for the teaching identity of pre-service Physical Education teachers, as well as the mediating role of academic engagement and intention to become a teacher, whereas a disempowering climate does not predict teaching identity. Therefore, this study underlines the relevance, for both teacher educators and researchers, of fostering empowering climates that promote academic engagement and strengthen intention to become a teacher as key drivers of teaching identity in Physical Education pre-service teachers.

Keywords: academic engagement, Achievement Goal Theory, intention to become a teacher, professional teaching identity, Self-Determination Theory, teacher education

Introduction

There is growing concern in teacher education about examining, analyzing, and optimizing the processes involved in building professional identity in order to prevent teachers from leaving the profession (OECD, 2020). More than 30 years of research on teaching have raised new research questions and methodological approaches to better understand how professional identity develops. In teacher education in general, and in Physical Education (PE) in particular, the different approaches that have been used have addressed the development of professional identity from a psychogenetic perspective based on the study of students' internal characteristics (Rubio-Valdivia et al., 2024; Granero-Gallegos et al., 2025). In line with the existing evidence, not only personal influences shape the construction of a teaching identity; socially situated influences, such as the classroom climate, have also been theoretically described as key factors in this process (Day, 2011). Therefore, and since these relationships have not been empirically tested from a quantitative standpoint, the present study seeks to understand the role of classroom motivational climates through cognitive elements in the development of teaching identity in PE pre-service teachers.

(Dis)empowering Climates

Although the classroom motivational climate has been identified as the cornerstone of all educational outcomes because it is intrinsically linked to the quality of the teaching–learning process (OECD, 2020), recent educational trends have highlighted the need to combine elements drawn from Achievement Goal Theory (AGT; Ames, 1992) and Self-Determination Theory (SDT; Ryan & Deci, 2017). To examine in greater depth the influence of the social environment in the classroom, Duda and Appleton (2016) outlined a hierarchical, integrative, and multidimensional conceptualization that incorporates the main dimensions of the social environment within AGT (task- and ego-involving climates) and SDT (autonomy support, control, and social support). According to Granero-Gallegos et al. (2023), and following Duda and Appleton's (2016) conceptualization, a teacher educator creates an empowering climate when they provide pre-service teachers with opportunities for choice (autonomy support); establish interpersonal criteria for success based on skill development, effort, and cooperation (task-involving climate); and make them feel valued and cared for as individuals (social support). In contrast, a teacher educator creates a disempowering climate when they establish interpersonal relationships based on rivalry and competitiveness (ego-involving climate) and

use controlling and pressuring strategies so that students feel, think, and act in a particular way (controlling style). Drawing on Duda and Appleton's (2016) multidimensional conceptualization and previous studies (Simon et al., 2025; Milton, Appleton et al., 2025), an empowering climate is expected to foster cognitive elements that are intrinsic to the education process, such as academic engagement, which can stimulate intentionality toward teaching behavior (e.g., intention to become a teacher) and, consequently, promote the development of teaching identity (Milton et al., 2025; Granero-Gallegos et al., 2025; López-García et al., 2022). Conversely, a disempowering climate is likely to undermine the cognitive processes developed by pre-service teachers, such as intention to become a teacher or academic engagement, thereby hindering the construction of a strong teaching identity (Milton et al., 2025; Granero-Gallegos et al., 2024; López-García et al., 2023).

Academic Engagement

Academic engagement has been conceptualized as a positive affective and mental state related to academic work that involves students' intention, interest, and effort invested in the learning process (Schaufeli et al., 2006). The conceptual framework proposed by Schaufeli et al. (2006) operationalized academic engagement through three dimensions: i) vigor (perception of high levels of energy in learning), ii) dedication (perceived involvement in academic tasks), and iii) absorption (perception of high levels of immersion that are expressed in any academic task). Specifically, research in teacher education has shown the role of academic engagement as an outcome of classroom climates (López-García et al., 2022), as well as an antecedent of future behaviors (intention to become a teacher) (López-García et al., 2023). However, although academic engagement has been widely used in teacher education and its influence on the development of professional identity has been examined (Pittaway & Moss, 2013), to the best of our knowledge no study has evaluated its potential positive influence on teaching identity despite its relevance in teacher education programs.

Intention to Become a Teacher

Intention to become a teacher refers to the degree of planning and effort that pre-service teachers invest in working as teachers in the future (Fishbein & Ajzen, 2010). Following the theoretical framework of the Theory of Planned Behavior, Fishbein and Ajzen (2010) proposed that behavioral intention is an immediate antecedent of the degree of effort that a

person is willing to invest in a given action. In this sense, intention to become a teacher is influenced by i) behavioral beliefs regarding positive or negative evaluations of teaching; ii) normative beliefs that give rise to perceived social pressure to perform certain behaviors; and iii) perceived behavioral control beliefs associated with a future behavior. Evidence in teacher education has examined the role of intention to become a teacher both as an antecedent of classroom climates (Granero-Gallegos et al., 2024) and as a precursor of key cognitive elements in the education process (López-García et al., 2023). Nevertheless, to the best of our knowledge no studies have examined the role of intention to become a teacher as a precursor of behavioral intention capable of developing professional identity in PE pre-service teachers. This represents a gap in the scientific literature and an important contribution of the present study.

Professional Teaching Identity

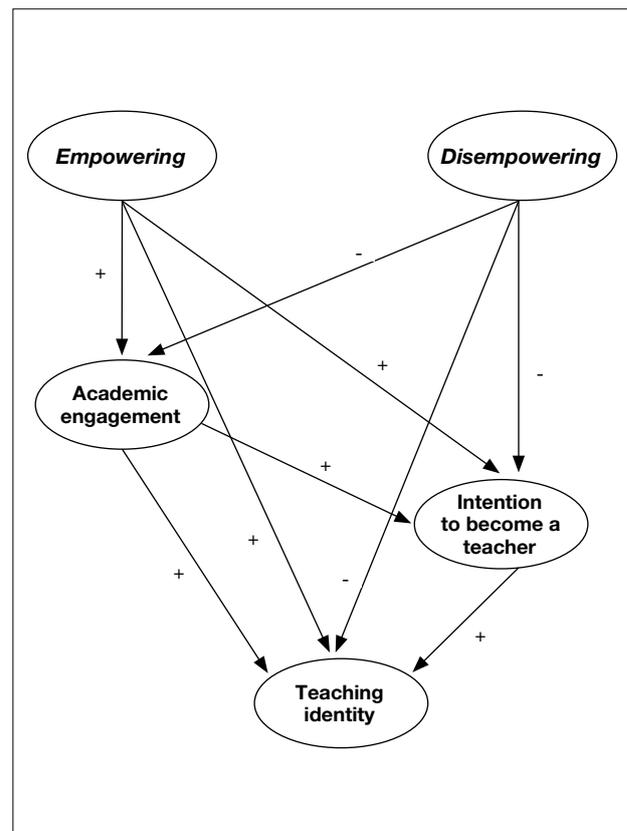
Teaching identity has been conceptualized as a theoretical construct that allows us to position ourselves as teachers in relation to others and that encompasses different activities as well as processes of categorization and identification (Gray & Morton, 2018). In this sense, a well-established professional identity fosters commitment to the teaching profession, supports ongoing professional development, facilitates the integration of innovative educational practices, and enables teachers to adapt to adverse situations (Beijaard et al., 2009). Consequently, authors such as Gray and Morton (2018) describe the construction of professional identity as a continuous process of accepting and building one's role, characterized by ongoing negotiation between external influences and the person (Reeves, 2018). Teaching identity is therefore not a static construct, but a fluctuating one that depends on various factors (e.g., psychological, social, personal) and is influenced by different perceptions of these factors (Day, 2011). For this reason, during teacher education, identity needs to be understood as a dynamic construct that continuously evolves through the interaction of internal (personal) characteristics and external (contextual) influences. Few studies, such as that by Rubio-Valdivia et al. (2024), have sought to understand the interaction of internal traits, and only Wong and Liu (2024) have examined the construction of teaching identity from the perspective of SDT. Thus, adding evidence on how teaching identity is constructed from the viewpoint of PE pre-service teachers represents an important contribution, as this study will provide insights into how the classroom climate created by the teacher educator influences the development of pre-service teachers' professional identity.

The Present Study

Given the importance of identity both during teacher education and throughout teachers' professional careers, analyzing the social factors that can foster professional teaching identity is highly relevant for its study. Moreover, to the best of our knowledge, no studies have considered Duda and Appleton's (2016) multidimensional conceptualization when examining the influence of (dis)empowering climates on professional teaching identity. The aim of this study was therefore to analyze the mediating role of academic engagement and intention to become a teacher in the relationship between (dis)empowering climates and teaching identity in pre-service teachers. Drawing on the postulates of SDT and AGT and on previous studies, a hypothesized model was developed (see Figure 1) to examine these relationships. The description of the present study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) initiative (von Elm et al., 2008; Sánchez-Martín et al., 2024a).

Figure 1

Hypothesized relationships between (dis)empowering climate and professional teaching identity through the mediating role of academic engagement and intention to become a teacher



Method

Design

This study used an observational, cross-sectional design. Participants were students enrolled in the Master's Degree in Secondary Education Teaching (MAES) at eight public universities in Andalusia (Spain). The inclusion criteria were: i) regular, face-to-face attendance at classes; and ii) being enrolled in the MAES in the PE specialization during the 2021/2022 academic year. The exclusion criteria were: i) not completing the questionnaire in full; and ii) not providing informed consent for data processing.

Instruments

Teacher educator-created (dis)empowering climate

The Educator-Created Empowering and Disempowering Climate Questionnaire (ECEDMCQ; Granero-Gallegos et al., 2024) was used. The ECEDMCQ consists of 21 items grouped into five factors: autonomy support (five items; e.g., "My teacher offered different opportunities and options"), social support (three items; e.g., "My teacher listened openly and did not judge personal feelings"), task-involving climate (four items; e.g., "The teacher expects us to learn new skills and acquire new knowledge and skills"), control (six items; e.g., "My teacher was less kind to those who did not try to see things his/her way"), and ego-involving climate (three items; e.g., "The teacher encourages students to outperform others"). Responses are given on a Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Academic engagement

The Spanish version of the Utrecht Work Engagement Student Scale (UWES-S; Schaufeli et al., 2002) was used. The UWES-S comprises 17 items grouped into three factors: vigor (six items; e.g., "I feel strong and vigorous in my studies"), dedication (five items; e.g., "My studies are stimulating and inspiring"), and absorption (six items; e.g., "I am immersed and engrossed in my studies"). Responses were given on a Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). In this study, academic engagement was used as a higher-order factor, as in previous research (López-García et al., 2022).

Intention to choose teaching as a career

The Spanish version of the Future Teaching Intention Scale (FTIS; Burgueño et al., 2022), based on Fishbein and Ajzen (2010), was used. This instrument includes three items (e.g., "I am determined to work as a teacher in the next 3 years") that assess pre-service teachers' future

intention to become teachers. Responses were given on a Likert-type scale ranging from 1 (extremely unlikely) to 7 (extremely likely).

Professional Teaching Identity (PTI)

The Spanish version (Granero-Gallegos et al., 2025) of Fisherman and Weiss's (2008) Student Teachers Professional Identity Scale was used to assess teaching identity. This instrument consists of nine items (e.g., "Being a teacher is an important part of my life") with responses on a Likert-type scale from 1 (strongly disagree) to 5 (strongly agree).

Procedure

First, the academic coordinators of the MAES at each university were contacted to request their collaboration and to provide information about the aims and characteristics of the project. Next, students were contacted by email and invited to complete an online questionnaire. The form outlined the study aims, the anonymity of their responses, and how to complete the scales. It also explained that they could withdraw from the study at any time without any impact on their academic performance. To ensure the quality of the online responses, the questionnaire was configured so that items could not be left unanswered, thereby avoiding missing data. A minimum reasonable completion time was set to detect excessively rapid responses, and response patterns were screened for inconsistencies. The risk of automated responses was minimized by distributing the link only to institutional email addresses. In total, 478 responses were recorded, and all participants provided informed consent before completing the questionnaire. The study followed the principles of the Declaration of Helsinki and the protocol was approved by the Research Ethics Committee of the University of Almería (Ref.: UALBIO2021/009).

Sample Size

An *a priori* power analysis was conducted to determine the required sample size using the Free Statistics Calculator (v.4.0) software. A minimum of 472 students was needed to detect effect sizes of $f^2 = .20$ with a statistical power of 90% and a significance level of $\alpha = .05$ in a structural equation model (SEM) with five latent variables and 20 observed variables.

Statistical Analysis

SPSS (v.29) was used to calculate descriptive statistics, skewness, kurtosis, reliability (McDonald's omega), and correlations between factors (Ibáñez-López et al., 2024).

Table 1
Descriptive statistics and correlations between variables

Variable	Range	<i>M</i>	<i>SD</i>	Q1	Q2	ω	1	2	3	4	5
1. Empowering climate	1-5	3.65	0.72	-0.12	-0.58	.88		-.26**	.36**	.02	.14**
2. Disempowering climate	1-5	2.03	0.82	0.83	0.03	.90			.07	.08	.08
3. Academic engagement	1-5	3.45	0.86	-0.38	-0.27	.95				.19**	.39**
4. Intention to become a teacher	1-7	5.95	1.54	-1.64	-2.09	.96					.61**
5. Teaching identity	1-5	4.20	0.74	-1.21	1.38	.91					

Note. **Correlation is significant at the .01 level; *M* = Mean; *SD* = Standard deviation; Q1 = Skewness; Q2 = Kurtosis; ω = McDonald's omega.

The hypothesized predictive relationships of (dis)empowering climates with teaching identity, with multiple mediation by academic engagement and intention to become a teacher, were tested using a latent-variable SEM performed with AMOS (v.29) (Sánchez-Martín et al., 2024b).

The analysis followed a two-step approach. First, a saturated model was examined, in which all dimensions were interrelated. Second, the predictive relationships in the hypothesized model were evaluated. In the SEM, university and gender were included as covariates, and model fit was assessed using the following indices: chi-square/degrees of freedom ratio (χ^2/df), Tucker–Lewis Index (TLI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA) with its 90% confidence interval (CI), and Standardized Root Mean Square Residual (SRMR). Acceptable values are $\chi^2/df < 5.0$, CFI and TLI $> .90$, RMSEA $< .08$, and SRMR $< .08$ (Tabachnick & Fidell, 2021).

Maximum likelihood estimation with a bootstrapping procedure of 5,000 resamples was used due to the lack of multivariate normality (Mardia's coefficient = 134.15; $p < .001$) (Kline, 2023). Indirect effects and their 95% CI were estimated using bootstrapping, and an indirect effect was considered significant ($p < .05$) when its 95% CI did not include zero (Shrout & Bolger, 2002). McDonald's omega (ω) values $> .70$ were considered to indicate good reliability (Viladrich et al., 2017).

Finally, explained variance (R^2) was considered as an effect size (ES; Dominguez-Lara, 2017), with values $< .02$ interpreted as small, around .13 as medium, and $> .26$ as large. In addition, 95% CIs for R^2 were used to ensure that no value fell below the minimum required for interpretation (.02).

Results

Participants

A total of 478 students (44.8% women, 54.8% men, and 0.2% another gender) enrolled in the PE specialization of the MAES from several public universities participated. Their ages ranged from 21 to 47 years ($M = 27.09$; $SD = 6.32$). Data were collected in May 2022 and there were no missing values.

Preliminary Analyses

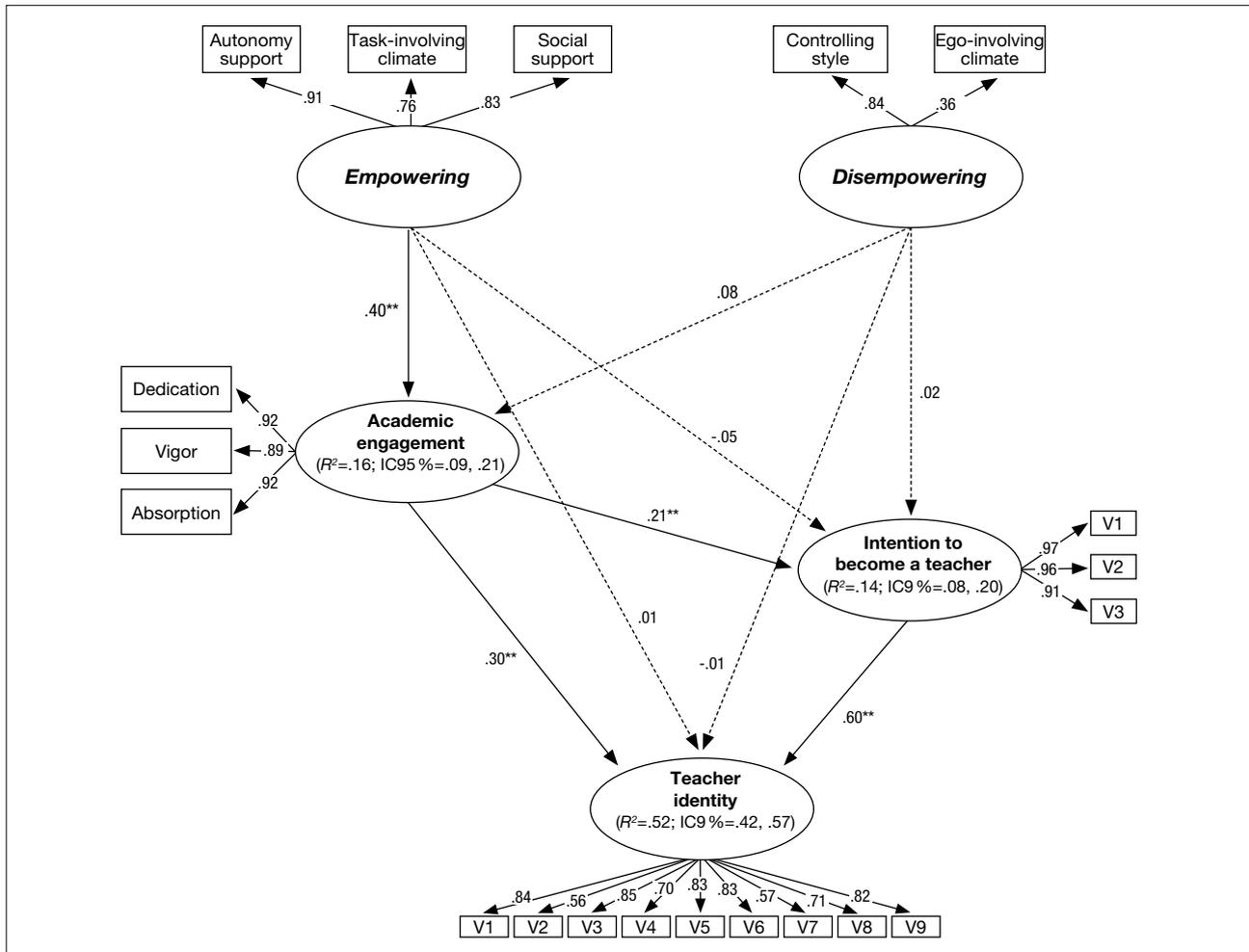
Table 1 presents descriptive statistics for the study variables, as well as reliability values (ω) and correlations between dimensions.

Main Analyses

In step 1, the SEM showed acceptable fit indices: $\chi^2/df = 2.62$, $p < .001$; CFI = .96; TLI = .95; RMSEA = .058 (90% CI = .052–.065); SRMR = .047. In step 2, the hypothesized SEM also showed acceptable fit: $\chi^2/df = 2.61$, $p < .001$; CFI = .96; TLI = .95; RMSEA = .058 (90% CI = .052–.065); SRMR = .047. Explained variance was 52% for teaching identity (large), 16% for academic engagement (medium), and 14% for intention to become a teacher (medium), indicating an adequate level of explained variance for the latent variables considered (Dominguez-Lara, 2017).

Figure 2

Predictive relationships between perceived (dis)empowering climate and professional teaching identity through the mediating role of academic engagement and intention to become a teacher



Note. ** $p < .001$. The dashed lines represent non-significant relationships.

As shown in Figure 2, academic engagement plays an important mediating role between empowering climate and teaching identity. No significant direct predictive relationships were found between disempowering climate and the other variables included in the SEM (academic engagement, $p = .088$; intention to become a teacher, $p = .527$; teaching identity, $p = .560$). The direct relationships between empowering climate and teaching identity ($p = .869$) and between empowering climate and intention to become a teacher ($p = .346$) were also not significant. In the SEM, however, there was a significant and positive direct predictive relationship between empowering climate and academic engagement ($p < .001$), between academic engagement and intention to become a teacher ($p < .001$), and between intention to become a teacher and teaching identity ($p < .001$). As can be seen, academic engagement is an important variable for improving teaching identity, as it significantly and positively mediates the relationship between empowering climate and teaching identity ($\beta = .12$;

$p < .001$). Finally, Figure 2 displays the 95% CIs for R^2 , confirming that these values can be considered measures of ES (Dominguez-Lara, 2017), and all of them are large.

Discussion

The aim of this study was to analyze the relationship between (dis)empowering motivational climates and teaching identity, considering the mediating role of academic engagement and intention to become a teacher in future PE teachers. The main results showed that empowering climate has an indirect and positive effect on teaching identity, highlighting the mediation of both academic engagement and intention to become a teacher.

The main findings revealed that (dis)empowering motivational climates do not directly predict personal teaching identity among future PE teachers. These results, which are inconsistent with previous studies (Day, 2011), may be due to the limited effect that socially situated

influences (motivational climate) have on the development and construction of professional teaching identity in these pre-service teachers (Martín-Gutiérrez et al., 2014). A context that promotes extrinsic sociogenetic elements without personal influences that support them will not foster the development of teaching identity. As authors such as Beg et al. (2021) note, identity construction involves ongoing negotiation between external influences and the person; therefore, (dis)empowering climates will exert an influence only when dimensions inherent to teacher education are taken into account. Another possible explanation for these results lies in the cross-sectional nature of the study, since examining socio-contextual classroom climates at a single time point may not sufficiently capture the development of teaching identity. Future research should address the influence of (dis)empowering climates throughout the teacher education process (e.g., during the MAES) and examine how classroom climates affect the construction of professional teaching identity.

The SEM shows that an empowering climate indirectly predicts teaching identity through the mediating role of academic engagement and through intention to become a teacher, which in turn is preceded by academic engagement. Although both mediation paths are weak, the effect of academic engagement between empowering climate and professional identity is greater than the mediating effect of intention to become a teacher preceded by academic engagement. It is noteworthy that the direct predictive relationship between empowering climate and intention to become a teacher was not significant. According to the literature, intention to engage in teaching is a key cognitive element for future professional practice in pre-service teachers (Burgueño et al., 2022; López-García et al., 2023). Based on the conceptualization of the Theory of Planned Behavior (Fishbein & Ajzen, 2010), empowering climate would be expected to affect pre-service teachers' perceived behavioral control, thereby increasing the antecedent of future behavior. However, our results do not fully fit this conceptualization, as a cognitive component such as academic engagement is needed to stimulate intention toward teaching (Schaufeli et al., 2002). Academic engagement thus acts as a fundamental pillar, not only to increase intention toward the teaching profession but also to foster identification with a teaching career.

Consistent with the hypothesized model, the results showed no mediating role of intention to become a teacher or academic engagement in the relationship between disempowering climate and teaching identity. These findings do not align with previous research, such as López-García et al. (2023), who reported that a disempowering climate in a

sample of pre-service teachers from different specializations (PE, history, biology, geology, mathematics, etc.) positively predicted intention to become a teacher. The inconsistency between our results and those of the aforementioned study may be related to the influence of the disciplinary field, in this case PE. According to Crum (2012) and Saiz-González et al. (2025), PE is a subject that does not always aim to foster learning, which may lead future teachers to adopt pre-established identities based on social norms rather than on the performance of teaching duties (Gray & Morton, 2018). Another possible explanation is the lack of a social dimension (coldness) in Duda and Appleton's (2016) theoretical conceptualization of a disempowering climate. Their model comprises three dimensions for empowering climate (autonomy support, task-involving climate, and social support) and two for disempowering climate (ego-involving climate and controlling style). The absence of a social dimension in disempowering climate may thus mean that less self-determined motivational climates do not foster teaching identity in future PE teachers.

Limitations and Future Directions

Despite its contribution, this study had several limitations. First, it relied on self-reports from PE pre-service teachers, which may lead to subjective responses regarding motivational climates. Moreover, this type of instrument may be subject to social desirability bias, especially in sensitive areas such as teaching identity. Future research should examine perceptions of motivational climates by combining different data collection tools (e.g., interviews, focus groups) and by including responses from teacher educators themselves.

Second, a non-random convenience sample was used, which limits the interpretation and generalization of the findings to the broader educational community. Future studies should examine the role of motivational climates in teaching identity across different pre-service teacher specializations.

Third, relevant contextual variables that might have influenced the results—such as the mode of instruction (e.g., face-to-face or online) or the characteristics of the university teachers responsible for the courses—were not controlled.

Fourth, authors such as Granero-Gallegos et al. (2024) and Espinoza-Gutiérrez et al. (2024) have highlighted the versatility of motivational processes in pre-service teachers. Future research should therefore use longitudinal designs to examine fluctuations in motivational processes and their impact on professional teaching identity.

Practical Implications

The findings of this study deepen and broaden our understanding of the role of motivational climates in developing teaching identity in PE pre-service teachers. They expand the evidence base supporting recommendations that PE teacher education programs foster empowering motivational climates. In addition, PE teacher educators should receive training on how to implement empowering climates that can stimulate the development of teaching identity.

To establish an empowering climate (see Appleton et al., 2016), PE teacher educators should apply strategies that include, among other aspects, providing social support to students (e.g., regularly implementing mentoring programs), promoting autonomy in learning (e.g., offering opportunities for choice), and fostering a learning-oriented environment (e.g., explaining the underlying usefulness of the proposed activities) (García-Fariña & Vázquez-Manrique, 2025; Ocete et al., 2025).

The findings of the present study suggest that creating and using such motivational strategies may promote the development of cognitive and intentional behaviors and, consequently, the development of professional teaching identity. In this regard, specific learning strategies such as service-learning and project-based learning, which are capable of developing specific teaching skills in future PE teachers, have gained increasing relevance in teacher education (Lobo-de-Diego et al., 2024; García-Fariña et al., 2024; Valdecabres & López, 2024).

Conclusions

In conclusion, to strengthen teaching identity in future PE teachers, it is necessary to create classroom contexts that foster academic engagement through empowering climates. PE teacher educators should therefore generate empowering classroom climates that build students' academic engagement in order to promote the development of a professional identity throughout their teacher education.

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Player Defaults in Professional Tennis Tournaments for Men From 1973 to 2024

Martí Casals^{1,2}, Victoria Peña³, José A. Martínez⁴, Rodrigo Ampuero^{1*}, Jordi Cortés⁵ & Ernest Baiget¹

¹ National Institute of Physical Education of Catalonia (INEFC), Barcelona (Spain).+

² Sport and Physical Activity Studies Centre (CEEAF), Faculty of Medicine, University of Vic-Central University of Catalonia (UVic-UCC), Barcelona (Spain).

³ Doctoral Program in Medicine and Biomedical Sciences, University of Vic – Central University of Catalonia, Vic (Spain).

⁴ Polytechnic University of Cartagena (Spain), member of European University of Technology (EUT+).

⁵ Department of Statistics and Operations Research and Institute for Research and Innovation in Health (IRIS), Polytechnic University of Catalonia, Barcelona (Spain).

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*Corresponding author:

Rodrigo Ampuero
rod.ampuero12@gmail.com

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Short track athlete in
mid-turn, with maximum
speed and focus on the ice.
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Abstract

In tennis, there are different types of situations in which players are unable to finish a match. *Defaults* refer to a player's disqualification for violating the conduct code during or before a match. This study describes defaults in ATP tournaments from 1973 to 2024, analyzing epidemiological patterns. The incidence proportion (IP) per 1,000 matches was 0.59 (95% CI: 0.48-0.71) before the match and 0.31 (95% CI: 0.23-0.39) during the match. The highest IP before the match occurred in 250 or 500 tournaments (IP: 0.83; 95% CI: 0.68-1.01) and on carpet surfaces (IP: 2.23; 95% CI: 1.59-3.05). Preliminary rounds and finals had IPs of 0.64 (95% CI: 0.51-0.79) and 0.74 (95% CI: 0.45-1.14), respectively. During matches, Masters and 250 or 500 tournaments had the highest IPs of 0.33 (95% CI: 0.15-0.63) and 0.33 (95% CI: 0.24, 0.45), respectively. Carpet courts showed again higher defaults (IP: 0.40; 95% CI: 0.16-0.82). These findings highlight the impact of tournament level, surface, and round on defaults.

Keywords: ATP, default, epidemiology, mental health, tennis

Introduction

Tennis players require extensive dedication to the sport, addressing both mental and physical essential aspects. This long-term, complex process highlights the importance of considering mental health for achieving high-level performance, especially regarding factors related to competitiveness and stress (Crespo & Reid, 2007; Gucciardi et al., 2015; Harris et al., 2021). Recent studies have proven that professional tennis players show an important increase in obsessive-compulsive symptoms, which may be related to the intense training and strict daily routines required for high performance. These psychological vulnerabilities, although initially adaptative, may evolve during times of adversity and may be reflected on their behavior on-court (Marazziti et al., 2021). During the competition, psychological factors such as decision-making ability, emotional control, self-confidence, and willpower, come constantly into play with varying intensity according to the game's evolution. These cognitive aspects and technical-tactical-physical abilities are fundamental to facing different situations as a professional player (Rodríguez & García, 2014). Mentally strong tennis players can maintain focus and self-talk aimed at intense emotional regulation, enabling them to better control stressful situations (Fritsch et al., 2020). Ineffective management of pressure and stress could lead to negative emotional reactions, which could influence their performance.

In tennis, there are different types of situations in which players are unable to finish a match or a tournament, having different consequences, as noted in Table S1 in the Supplementary Material. *Defaults* refer to a player's disqualification for violating the conduct code during a match, or to total retirement from all events due to such a violation during the tournament but not in a match (ATP, 2024). Defaults during a match may be associated with the psychological factors mentioned above, which are strongly related to the management of critical moments during matches (Houwer et al., 2017). Defaults before the match (disqualifications occurring before the match starts) are of a more heterogeneous nature. A player's disqualification (as during a match) can be associated with psychological factors linked to stress and self-control (Englert, 2016; Tossici et al., 2024), but defaults before the match can also be due to other causes, such as doping, betting, the player not being dressed or equipped in a professional manner, or a default for lack of punctuality (Fletcher, 2024; TADP rules, 2024). According to the penalty regulations, the first conduct violation during a match results in a warning, the second in a point-loss penalty, and each subsequent sanction after the third carries a game penalty. Nevertheless, after the third

code violation, the ATP supervisor will assess whether each additional infraction will constitute a default that is definitive and not subjected to appeal (ATP, 2024; International Tennis Federation, 2023). As for the consequences of default, in accordance with Association of Tennis Professionals (ATP) regulations, a disqualified or withdrawn player forfeits all prizes and points earned in that tournament event, in addition to receiving a financial penalty (ATP, 2024).

Among the most notorious cases of default during a match in tennis history is the case of Novak Djokovic who was disqualified from the 2020 US Open tournament during the fourth round for accidentally hitting a line judge with a ball. This disqualification allowed his opponent to advance to the next round without having to complete the match (Bodo, 2020). Also, at the 2009 US Open 2009, Serena Williams was disqualified in the semifinal against Kim Clijsters after threatening a line judge (Donegan, 2009). More recently, Russian player Andrey Rublev was defaulted from the 2024 Dubai Tennis Championship for yelling at a line judge (Reuters, 2024).

In the existing literature, different observational studies have shown an increase in the frequency of uncompleted matches—mainly due to injuries—among professional tennis players in recent years (Breznik & Batagelj, 2012; Maquirriain & Baglione, 2016; Montalvan et al., 2024; Okholm Kryger et al., 2015; Palau et al., 2024). However, to date, no studies have been published with the aim of describing and analyzing the factors associated with matches not completed due to defaults. Additionally, this type of disqualifying situation often attracts significant media attention, as the media frequently explore how and under what circumstances professional players exhibit this kind of behavior. Therefore, the aim of this study is to describe defaults in ATP tournaments between 1973 and 2024, analyse their epidemiological patterns, and identify possible associated factors. Given that defaults during a match are primarily linked to psychological factors such as stress management, whereas pre-match defaults have a broader set of causes, this research also provides a separate analysis of both types.

Materials and Methods

Study Design and Sample

An observational, retrospective cohort study was conducted. A database of 186,224 matches from 1973 to 2024, containing information on ATP Tour tournaments, was

used. The source was the GitHub repository https://github.com/JeffSackmann/tennis_atp, which compiles information from the official pages of various ATP tournaments (Table S2 in the Supplementary Material).

Variables

The outcome of interest was “Default” (Yes/No), which was further classified into “Default Before” (disqualification occurring before the match begins) and “Default During” (disqualification occurring during the match due to player conduct). The match- and tournament-related variables are detailed in Table S3 of the Supplemental material. In addition, the differences in age and ranking between players in each match was evaluated.

Statistical Analysis

Absolute (n) and relative (%) frequencies were computed for categorical variables, while measures of central tendency and dispersion were calculated for continuous variables. A bivariate descriptive analysis was performed to characterize matches and players when a default occurred. The cumulative incidence or incidence proportion (IP) was calculated using the formula $i = e/n$, where e is the number of events (defaults) during the study period and n is the total number of exposed matches per 1,000 played matches. The IP of defaults was plotted across the range of years included in this study.

The number of defaults, the exposure as the number of matches, the IP, and its 95% confidence interval (95% CI) were provided for each category of relevant factors. In addition, following the STROBE statement for observational studies (Vandenbroucke et al., 2014) and the CONSORT statement for randomized controlled trials (Moher et al., 2010), relative and absolute measures of association between factors and the occurrence of defaults were provided. These were expressed as cumulative incidence ratio (CIR) and with their 95% CI and as risk difference (RD) with their 95% CI. CIR was estimated as the ratio of IPs between the two specified subgroups (i.e., clay vs. hard surface). Furthermore, the absolute measure of RD was calculated by subtracting the rates of the two exposure groups.

Measures of association were calculated with 95% CI. The significance level was set at $\alpha = .05$.

All analyses were performed using version 4.1.3 of the R statistical software. The R package *compareGroups* (Subirana et al., 2014) was used to describe characteristics according to the occurrence of defaults. The *epi.2by2* function of the R package *epiR* (Stevenson et al., 2024), with the setting method as cohort time, was used to calculate the

incidence rates. The CIR was calculated using the function *pois.exact* from the *epitools* package. Most of the graphics were produced using the *ggplot2* package (Wickham, 2009). The reproducible code used in this study is available on a publicly accessible GitHub repository (https://github.com/marticasals/default_ATP/tree/main), allowing for the transparency and replicability of the statistical analysis.

Results

Exploratory Analysis of ATP Matches During the Period 1973-2024

181,239 (97.32%) out of 186,224 ATP matches studied were completed (Table 1). The median number of games per match was 22 (Q1:18-Q3:29). The majority of players were right-handed, both those who made it through the round (84.62%) and those who did not (84.56%). The median age difference between players was 3.35 years (Q1:1.39-Q3:5.59), and the median ranking difference was 46 positions (Q1:17-Q3:97).

Table 1

Frequency and percentage of each match according to tournament level, surface, sets, round, and match outcome

Variable	Frequency	Percentage
Tournament level		
250 or 500	126,041	67.68%
Grand Slams	32,723	17.57%
Masters	26,928	14.46%
Tour Finals	532	0.29%
Surface		
Carpet	17,491	9.39%
Clay	64,984	34.9%
Grass	21,174	11.37%
Hard	82,575	44.34%
Sets		
3	159,162	85.47%
5	27,062	14.53%
Round		
Final	27,162	14.59%
Preliminary	133,166	71.51%
Qualifying	25,896	13.91%
Match outcome		
Complete	181,239	97.32%
Default	166	0.09%
Retirement	4010	2.15%
W/O	798	0.43%
Unknown	11	0.01%

W/O = Walkover

Descriptive Characteristics of Defaults

A total of 166 defaults were registered (0.09%), of which 109 (65.66%) occurred before the start of the match and 57 (34.34%) during play. The majority of defaults took place in 250 or 500 tournaments, with 105 (0.08%) occurring before the match and 42 (0.03%) during the match. Defaults were most common in preliminary rounds, with 85 (0.06%) before the match and 39 (0.03%) during the match. The IP of defaults was 0.89 per 1,000 matches (95% CI: 0.76-1.04), with 0.59 per 1,000 matches (95% CI: 0.48-0.71) occurring before the match and 0.31 per 1,000 matches

(95% CI: 0.23-0.39) occurring during the match.

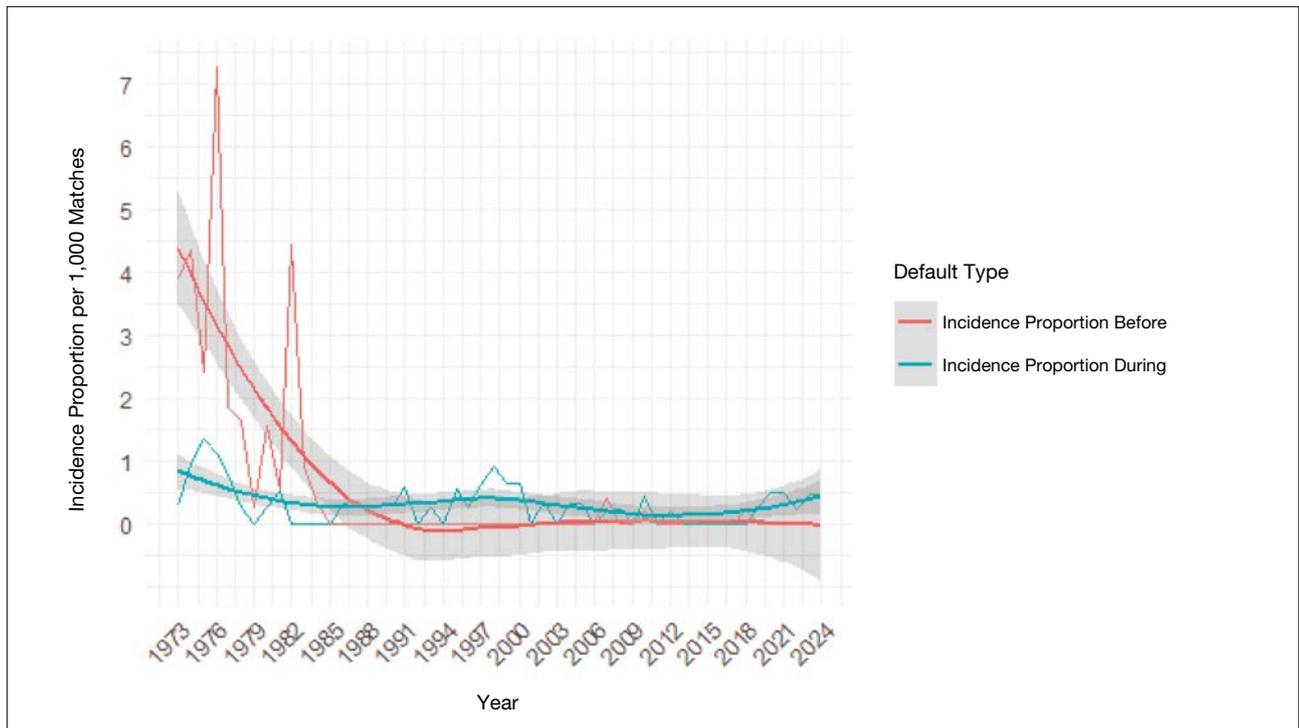
Figure 1 shows the trend in the incidence of defaults over time, differentiated by whether defaults occurred before or during the match. It can be observed that the incidence of defaults before the match was higher in the initial period, with a decreasing trend from 1973 to 1983 and a marked peak in 1976. The incidence of defaults during the match also followed a decreasing trend, albeit at a lower rate compared to defaults before the match. From the mid-1980s onwards, the IP for both types of defaults remained relatively constant over the years, with minor fluctuations.

Table 2

Summary descriptives of 'Defaults' (before and during the match)

Variable	Default Before		Default During	
	Yes N = 109	No N = 186,115	Yes N = 57	No N = 186,167
	n (%)	n (%)	n (%)	n (%)
Tournament level				
250 or 500	105 (0.08%)	115,983 (99.9%)	42 (0.03%)	125,999 (100.0%)
Grand Slams	2 (0.01%)	32,721 (100.0%)	6 (0.02%)	32,717 (100.0%)
Masters	2 (0.01%)	26,926 (100.0%)	9 (0.03%)	26,919 (100.0%)
Tour Finals	0 (0.00%)	532 (100%)	0 (0.00%)	532 (100%)
Surface				
Carpet	39 (0.22%)	17,452 (99.8%)	7 (0.04%)	17,484 (100.0%)
Clay	41 (0.06%)	64,943 (99.9%)	17 (0.03%)	64,967 (100.0%)
Grass	5 (0.02%)	21,169 (100.0%)	5 (0.02%)	21,169 (100.0%)
Hard	24 (0.03%)	82,551 (100.0%)	28 (0.03%)	82,547 (100.0%)
Round				
Final	20 (0.08%)	27,142 (99.9%)	13 (0.05%)	27,149 (100.0%)
Preliminary	85 (0.07%)	133,081 (99.9%)	39 (0.03%)	133,127 (100.0%)
Qualifying	4 (0.02%)	25,892 (100.0%)	5 (0.02%)	25,891 (100.0%)
Sets				
3	108 (0.07%)	159,054 (99.9%)	48 (0.03%)	159,114 (100.0%)
5	1 (0.00%)	27,061 (100.0%)	9 (0.03%)	27,053 (100.0%)

Figure 1
Incidence proportion of 'Defaults' (Before and During the match) over time



Epidemiology Measures of Defaults

The highest IP of defaults before the match was registered in 250 or 500 tournament levels, with a value of 0.83 (95% CI: 0.68 - 1.01). Matches played on carpet surfaces had a significantly higher IP of defaults, at 2.23 (95% CI: 1.59-3.05), compared to those on clay courts, which

had an IP of 0.63 (95% CI: 0.45-0.86). There was a significant increase in the risk of defaults on carpet surfaces compared to clay courts, with a CIR of 3.53 (95% CI: 2.28-5.48) and an RD of 1.60 (95% CI: 0.87-2.32). Regarding rounds, the preliminary rounds had an IP of 0.64 (95% CI: 0.51-0.79), while the finals had an IP of 0.74 (95% CI: 0.45-1.14) (Table 3).

Table 3
Incidence proportion (IP), cumulative incidence ratio (CIR), risk difference (RD) and their corresponding 95% confidence intervals (95% CI) of defaults before the match according to tournament level, surface, sets and round

	no. Default Before	no. Matches	IP (95% CI)	CIR (95% CI)	RD (95% CI)
Tournament level					
Grand Slam	2	32,723	0.06 (0.01–0.22)	Ref.	Ref.
Master	2	26,928	0.07 (0.01–0.27)	1.22 (0.17–8.63)	0.01 (-0.12–0.15)
250 or 500	105	126,041	0.83 (0.68–1.01)	13.63 (3.36–55.22)	0.77 (0.59–0.95)
Tour Finals	0	532	0.00 (0.00–6.91)	N.A.	N.A.
Surface					
Clay	41	64,984	0.63 (0.45–0.86)	Ref.	Ref.
Grass	5	21,174	0.24 (0.08–0.55)	0.37 (0.15–0.95)	-0.39 (-0.68–0.11)
Hard	24	82,575	0.29 (0.19–0.43)	0.46 (0.28–0.76)	-0.34 (-0.57–0.11)
Carpet	39	17,491	2.23 (1.59–3.05)	3.53 (2.28–5.48)	1.60 (0.87–2.32)
Round					
Qualifying	4	25,896	0.15 (0.04–0.40)	Ref.	Ref.
Preliminary	85	133,166	0.64 (0.51–0.79)	4.13 (1.52–11.26)	0.48 (0.28–0.69)
Final	20	27,162	0.74 (0.45–1.14)	4.77 (1.63–13.94)	0.58 (0.23–0.94)

NA = Not available; Ref = Reference

Table 4

Incidence proportion (IP), cumulative incidence ratio (CIR), risk difference (RD) and their corresponding 95% confidence intervals (95% CI) of defaults during the match according to tournament level, surface, sets and round

	no. Default During	no. Matches	IP (95% CI)	CIR (95% CI)	RD (95% CI)
Tournament level					
Grand Slam	6	32,723	0.18 (0.07–0.40)	Ref.	Ref.
Master	9	26,928	0.33 (0.15–0.63)	1.82 (0.65–5.12)	0.15 (-0.11–0.41)
250 or 500	42	126,041	0.33 (0.24–0.45)	1.82 (0.77–4.27)	0.15 (-0.03–0.33)
Tour Finals	0	532	0.00 (0.00–6.91)	N.A.	N.A.
Surface					
Clay	17	64,984	0.26 (0.15–0.42)	Ref.	Ref.
Grass	5	21,174	0.24 (0.08–0.55)	0.90 (0.33–2.45)	-0.03 (-0.27–0.22)
Hard	28	82,575	0.34 (0.23–0.49)	1.30 (0.71–2.37)	0.08 (-0.10–0.25)
Carpet	7	17,491	0.40 (0.16–0.82)	1.53 (0.63–3.69)	0.14 (-0.18–0.46)
Round					
Qualifying	5	25,896	0.19 (0.06–0.45)	Ref.	Ref.
Preliminary	39	133,166	0.29 (0.21–0.40)	1.52 (0.60–3.85)	0.10 (-0.09–0.29)
Final	13	27,162	0.48 (0.25–0.82)	2.48 (0.88–6.95)	0.29 (-0.02–0.60)

NA = Not available; Ref = Reference

The highest IP of defaults during the match was registered in Masters tournaments, with an IP of 0.33 (95% CI: 0.15-0.63), and in 250 or 500 tournament levels, with a value of 0.33 (95% CI: 0.24-0.45). Matches played on carpet surfaces had a higher IP of defaults, at 0.40 (95% CI: 0.16-0.82), compared to clay courts, which had a value of 0.26 (95% CI: 0.15-0.42). Preliminary rounds saw an IP of 0.29 (95% CI: 0.21-0.40), and finals had an IP of 0.48 (95% CI: 0.25-0.82) (Table 4).

Discussion

The objective of this study was to describe the defaults produced between 1973 and 2024 by analyzing 186,224 ATP Tour matches. It should be noted that, to our knowledge, there are no previous studies that analyze defaults in this context. Additionally, this study stratified the results by considering two distinct types of defaults: before and during the match. This stratification allows for a more nuanced understanding of the factors contributing to defaults and their respective impacts. Therefore, this investigation could serve as a starting point to analyze this understudied issue in tennis, which has also received considerable media attention in recent years (Lewis, 2023; Livaudais, 2024; Reuters, 2024; The Sydney Morning Herald, 2020). A very low IP value was noted due

to the high-level players used in this investigation. More defaults were observed in best-of-3-sets matches and on carpet surfaces, with a high probability of being defaulted in advanced rounds (i.e., finals).

The IP of defaults was approximately 1 per 1,000 matches, mainly because of the quality of the sample (professional tennis players). With a strong mindset and sufficient emotional control, they can handle stressful and high-pressure situations properly. In addition, being defaulted has a multidirectional impact, including economic fines, loss of ranking points and—even—a negative self-image review. Our analysis also shows a decreasing trend in the incidence over the years. However, this trend has not always been constant; between 1970 and 1990, the proportion of defaults reached almost 7 per 1,000 matches. During this period, tennis faced behavioral problems both on- and off-court. In this environment, players such as Ilie Năstase, Jimmy Connors, and John McEnroe emerged, building their reputations around images of “bad boys” and exhibiting lower levels of sportsmanship, honesty, and courtesy toward officials (Lake, 2015).

Currently, just as with physical and technical preparation, psychological stress factors are better understood, and psychological preparation is much more specific. Many players work with sports psychologists who aim to help them

deal with match pressure. This approach has significantly improved their ability to handle stressful situations on the court (Beckmann et al., 2021; Cowden et al., 2016; Pineda-Hernández, 2022). Additionally, with the increased level of professionalism among players over the years, there has been a clear trend toward a reduction in defaults related to issues such as not being dressed or equipped in a professional manner, or lack of punctuality.

The decreasing trend in the incidence over the years has been more prominent for defaults before a match than for defaults during a match, and both incidences have been similar since the mid-1980s. There is a growing demand for sports psychologists to help athletes overcome mental barriers and improve their performance (Weir, 2018), and as Walker et al. (2021) indicated, mental health problems affect everyone, including those who are among the best on the planet in terms of physical and sporting ability.

Defaults during a game are relatively rare events, but they are still present, even with a high level of professionalism and advances in mental health management. Further research should explore more deeply the complex interactions between mental health management, anger and aggressive or violent behavior during a game. In other sports, such as basketball, the National Basketball Association (NBA) teams began to incorporate sports psychologists at the beginning of the millennium. Now, the NBA requires all 30 teams to add, at a minimum, one full-time licensed mental health professional in the form of a psychologist or behavioral therapist (*NBA's Psychiatry Program*, n.d.). In addition, in 2018, the NBA and the National Basketball Players Association announced that they had worked together to develop a mental wellness program for the league's players (Aldridge, 2018). However, as Lev et al. (2022) found in their analysis of NBA Finals broadcast over twenty years, from 1998 to 2018, although the number of physical incidents decreased, symbolic violence increased starting in 2014, to the extent that symbolic incidents became more frequent than physical incidents. In fact, there are NBA players such as Jimmy Butler who have publicly admitted they want more brawls in the matches (Caparell, 2022).

Therefore, it seems there is a substratum of antisocial behavior in sports that is difficult to mitigate even with advances in mental preparation and psychological management (Kavussanu & Al-Yaaribi, 2019). As stated by Monaci & Veronesi (2018), in a sports competition, the principal characteristics for excelling are aggressiveness, dominance, competitive spirit—all stereotypically “male” features—. Monaci & Veronesi (2018) found in tennis

that a competitive sport context activates the masculine dimension. This may be one explanation for why, in a sport such as tennis, with practically no physical interaction between opponents or among players and referees, “bad behavior” continues to be present (Monaci & Veronesi, 2018). Consequently, although the incidence of defaults during a match in tennis is low, and it has softly declined over time, it is still a matter of concern. For example, in 2022, 18-time Grand Slam winner Chris Evert stated she was worried about elite tennis players having “breakdowns” after a spate of angry, aggressive behavior (Martin, 2022). Kavussanu (as cited in University of Birmingham, 2022) suggests that the causes of this behavior are an individual's values acquired at a young age by modeling the conduct of others in one's social environment, such as parents, coaches, and peers. The researcher stresses the role of coaches and the way they interact with athletes as a key factor in instilling the value of respect for others and minimizing unsporting conduct. Furthermore, to mitigate this aggressive behavior, she proposes imposing significant consequences on players, such as increasing fines and even exclusion from future tournaments (University of Birmingham, 2022).

Defaults occurred more frequently in 3-set matches rather than in 5-set matches. These 5-set matches are played in the most important competitions throughout the year, called Grand Slams, in which the financial rewards, plus the number of ranking points possibly earned, may help explain why players avoid defaults at these tournaments. Regarding this, subsequent sanctions differ according to the type of tournament. For example, fines for unsportsmanlike actions are \$30,000 for 250 tournaments and \$40,000 for 500 tournaments, while the amount increases to \$60,000 for Masters 1000 tournaments and \$100,000 for Grand Slams (ATP, 2024). This suggests that players tend to avoid violating the code of conduct in tournaments where the penalties are more rigorous; therefore, these disqualifications occurred mostly at 250 or 500 tournaments, in which carpet surfaces are the most commonly used. Hence, defaults were related to carpet-surface matches showing the highest IP. This demonstrates a strong correlation between tournament level, sets played, game surface, and the default situation.

Moreover, players are more likely to receive a default in the final rounds rather than in the preliminary and qualifying rounds. As players advance through the rounds, the relevance of each match—and consequently the pressure of each one, as well as the cumulative pressure of the entire competition—significantly increases. Unlike in other sports, such as football, tennis players are restricted from communicating,

interacting, or seeking guidance from their coaches or support personnel during competition, which adds another layer of pressure (Cowden et al., 2016). Probably for this reason, in the final rounds, situations of high psychological tension often occur, making it more likely for players to display inappropriate behaviors.

One important limitation of this research is the absence of specific reasons for defaults in the ATP archives, which restricts a deeper understanding of the nature of these defaults. However, this study underscores the critical need for better reporting and documentation of the causes of defaults. Improved reporting can facilitate future research, particularly in the area of mental health in tennis. The results of this study may be useful as practical guidance for ATP organizers, given the valuable causes mentioned that could possibly trigger defaults. This guidance should also involve referee staff, who are among the entities responsible for calling a default. A more comprehensive approach and understanding of these indicators may help referees anticipate when such situations are likely to occur. Furthermore, systematically recording and analyzing this information is essential for coaching staff, researchers, and, most importantly, for safeguarding health and well-being of the players. By addressing this gap, we can gain better insights into the factors contributing to defaults and develop targeted interventions to support players' health and performance.

Conclusions

This is the first investigation ever carried out describing default situations in professional tennis from 1973 to 2024 and analyzing incidence patterns and associated factors. The general IP is of very low value, probably due to the high level of the players. There is a decreasing trend in the incidence over the years, with a slight increase between 1970 and 1990. Defaults occurred more frequently in 3-set matches rather than in 5-set matches and at the 250 or 500 tournaments level. Carpet was the most common surface in which this disqualification occurred. There is a low probability of getting a default in preliminary and qualifying rounds. Consequently, tournament importance—considering round-played, prize money and ranking points to be earned—affects directly on defaults.

Authors' Contributions

All authors wrote and critically reviewed the article. All authors have approved the final version of the manuscript and agree with the order of presentation of the authors.

Ethics Statement

No ethical approval was needed for carrying out this research, as all the information used and reported for analysis is freely available online.

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Supplementary Material

Table S1

Nomenclature for Uncompleted Matches in Tennis and Their Impact. (Adapted from "The 2023 ATP Official Rulebook")

Terms	Description	Ranking	Money prize
Retirements	Occurs when a player is forced to leave a match during its course due to injury, illness, or other circumstances that prevents him from continuing to play. In this case, the victory is awarded to the opponent.	The absent player keeps the points earned in previous matches in the tournament.	The player who is absent generally receives the money prize corresponding to his performance in the tournament up to that point.
Withdrawals	Occurs when a player voluntarily withdraws from the tournament prior to his scheduled match due to injury, illness, or other personal reasons.	The player who withdraws does not earn points for the tournament.	The player who withdraws does not receive financial rewards.
Walkover	Occurs when a player wins a match without playing due to the absence of the opponent. This may be due to injury, illness, or other personal circumstances that prevent the opponent from competing.	The player who receives the walkover earns points equivalent to a victory.	The player who receives the walkover is awarded the money corresponding to his/her performance in that round.
Default	Occurs when a player is disqualified for a single code violation, as stated in the Penalty Schedule during the match, or when a player is removed for a single code violation during the event, but not during the match.	The disqualified player does not earn ranking points.	The disqualified player may be fined and forfeit tournament prizes.

Table S2

Men's Circuits and Tournaments (Adapted from "The 2023 ATP Official Rulebook")

Circuit	Level	Tournament
ATP tour	First level of professional tennis	Grand Slam
		ATP Finals
		ATP Masters 1000
		ATP 500
		ATP 250

Table S3
Description of Match- and Tournament-Related Covariates

Variable	Description	Values
Tournament	Tournament level	250 or 500 Grand Slams Tour Finals Masters
Surface	Type of surface on which the match is played	Carpet Clay Grass Hard
Set	Match played at best of 3- or 5-sets	3 5
Round	Tournament round with the following categorization: Qualifying: includes qualifying rounds Q1, Q2 and Q3 Preliminary: Includes R128, R64, R32, R16 and RR Final: Includes QF, SF and F	Qualifying Preliminary Final
Year	Year in which the match was performed	
Games	Sum of the games won by the winning player in each set and the games won by the losing player in each set. In short, the total number of all the games played in the match.	
Final match	Completed and uncompleted matches. In the case of uncompleted matches, the reason is indicated.	Completed Default Retirement W/O Unknown
Moment default	Time at which the default occurs, whether it is before or during the match.	Before During



Assessment of Hand-Eye-Laterality and Its Relationship With Technique in High-Level Tennis Players

Miquel Moreno^{1,2*}, Josep-Maria Losilla^{2,4}  & Lluís Capdevila^{2,3} 

¹ Department of Physical Activity Sciences. University of Vic - Central University of Catalonia, Vic, Barcelona, (Spain).

² Sport Research Institute, Autonomous University of Barcelona, Bellaterra, (Spain).

³ Sport Psychology Laboratory, Department of Basic Psychology, Autonomous University of Barcelona, Bellaterra (Spain).

⁴ Department of Psychobiology and Methodology of Health Sciences, Autonomous University of Barcelona, Bellaterra (Spain).



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*Corresponding author:

Miquel Moreno
miquel.moreno@uvic.cat

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Short track athlete in
mid-turn, with maximum
speed and focus on the ice.
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Abstract

The hand-eye laterality profile (HELP) is a factor that may influence performance and technical fundamentals in tennis. This study aimed to: (a) assess the reliability of the hand-eye dominance test and the footwork preference test in tennis players; (b) analyze the distribution of the HELP profile in a sample of high-level tennis players; and (c) examine the relationship between the HELP profile and foot positions in different strokes involving movement. A sample of 173 tennis players (77 women and 96 men; mean age = 15.83 ± 2.86 years, range 11-23) was assessed. All of them were part of the *Centro de Referencia* program of the Catalan Tennis Federation, which brings together the most outstanding players in Catalonia, selected according to competitive performance and technical potential criteria. A standardized and validated method was applied to determine their HELP profile. The results confirmed that both the HELP test and the footwork preference test are reliable tools for assessment in tennis. In addition, 42.2% of the players showed a crossed profile (C-HELP), a proportion higher than in the general population. Specific patterns of foot position were also identified according to laterality profile, suggesting that the HELP profile influences stroke technique and tennis biomechanics. These findings support the relevance of hand-eye laterality in tennis and suggest that these tests are useful for tailoring training in high-level players.

Keywords: biomechanics, footwork, hand-eye laterality, HELP, technical fundamentals, tennis

Introduction

The hand-eye laterality profile (HELP) refers to the relationship between a person's dominant hand and dominant eye and can be classified into two main types: a) crossed profile (C-HELP), when hand and eye laterality do not coincide; and b) homogeneous profile (UC-HELP), when hand and eye laterality coincide.

Recent research has shown growing interest in studying HELP in sport, revealing a higher prevalence of certain profiles in specific sports compared with the general population. For example, a higher proportion of the C-HELP profile has been observed in athletes than in non-athletes in sports such as golf, tennis, soccer, volleyball, handball, basketball, hockey, softball, and water polo (Moreno et al., 2022). In contrast, the UC-HELP profile appears advantageous in shooting sports, as it is more common than in the general population (Laborde et al., 2009; Razeghi et al., 2012).

Beyond the study of profile distribution, some authors have found relationships between HELP and motor performance. Castañer et al. (2018) identified an association between certain laterality profiles and the execution of complex movements in athletes, suggesting the influence of motor and ocular laterality on these movements. In addition, Díaz-Pereira et al. (2023) highlighted that lateral preference is related to motor creativity, a key factor in adapting to and learning sport skills. On the other hand, Balci et al. (2021) investigated whether HELP influenced visual reaction time in swimmers and concluded that no significant differences existed between profiles. However, they observed that the combination of the hand opposite to the dominant eye did significantly affect performance in visual reaction tasks. Evidence that certain hand-eye laterality patterns are associated with faster reaction times supports the relevance of investigating their role in perceptual performance in sport (Azémar, 2003; Dane & Erzurumluoglu, 2003).

In tennis specifically, it has been hypothesized that HELP may influence performance, making it a potentially relevant factor for training and talent identification (Moreno et al., 2022; Peters & Campagnaro, 1996). Previous studies have reported that 42% of the top 50 tennis players in the ATP rankings presented a C-HELP profile (Dallas et al., 2018), a figure significantly higher than the 10%–30% range observed in the general population (Robinson et al., 1997). Bache and Orellana (2014) also summarized the observations of Dorochenko (2013), who noted that most of the ATP top 10 had a C-HELP profile. Subhashree and Farzana

(2025) concluded that tennis players with a C-HELP profile have greater serve accuracy. From a biomechanical and descriptive standpoint, Garipuy and Wolff (1999) reported that HELP profile may influence the characteristics of tennis strokes, such as body position and rotation during execution. According to these authors, players with a C-HELP profile tend to perform greater trunk rotation in forehand strokes, resulting in more neutral or semi-open foot positions. In contrast, players with a UC-HELP profile tend to hit the forehand from more open positions, requiring greater body rotation in backhand strokes.

Multiple studies have also underscored the importance of perceptual strategies for gathering and searching for information in tennis as trainable, performance-determining elements (Shim et al., 2005; Costa et al., 2023; Williams & Davids, 1998). Evidence further indicates that perceptual skills are related to stroke accuracy and overall motor timing (Özmen et al., 2020). In this context, our study may provide useful information on how HELP profile shapes perception and information processing during play, influencing stroke biomechanics through preferred patterns of footwork and body positioning.

However, some findings related to HELP should be interpreted with caution because of methodological limitations in previous research. In the studies by Bache and Orellana (2014) and Dorochenko (2013), the methods used to determine the prevalence of the C-HELP profile were not specified, whereas in the study by Dallas et al. (2018) ocular laterality was measured subjectively and without standardization. Moreover, many of the observed effects on performance are indirect, based on profile distribution, making it difficult to establish causal relationships (Moreno et al., 2022).

The present study sought to overcome these methodological limitations and determine the relationships between HELP and tennis technique in order to understand its impact on this sport. Specifically, the objectives were to: a) examine the validity and reliability of the hand-eye dominance test protocol proposed by Moreno et al. (2022) and of the footwork preference test, an original contribution based on an internal tool used by the Catalan Tennis Federation; b) determine the distribution of hand-eye laterality profiles (HELP) in a sample of high-level tennis players and identify whether there is a higher concentration of the crossed profile (C-HELP) compared with the general population using an objective, standardized, and validated HELP measurement method; and c) explore the relationship

between HELP profile and technical aspects of tennis by analyzing how HELP influences the technical fundamentals of footwork and foot position in strokes performed after forward, backward, and lateral movements.

Method

Participants

This study involved the voluntary participation of 173 tennis players enrolled in the talent identification and monitoring program of the Catalan Tennis Federation, known as *Centre de Referència*. The sample comprised 77 women and 96 men (mean age = 15.83; SD = 2.86; range 11–23 years). This program, implemented at the High-Performance Center (CAR) in Sant Cugat del Vallès between 2019 and 2023, brought together the most outstanding players in Catalonia (Spain). Table 1 summarizes the main descriptive characteristics of the sample. The selection included all semifinalists in the Catalan championships for each age group and was complemented by other players chosen according to the technical criteria

of the Catalan Tennis Federation talent selection team. Data were processed anonymously, and all participants, or their legal guardians in the case of minors, provided written informed consent. The study was conducted in accordance with the Ethics Committee for Human Experimentation of the Autonomous University of Barcelona (protocol code CEEAH-5745). The table with pseudo-anonymized data is available in CORA_RDR <https://doi.org/10.34810/data2110>).

Procedure

Assessment of hand-eye laterality profile (HELP)

HELP profile was assessed in all study participants ($n = 173$). Dominant hand was determined by observing the gripping hand in the forehand stroke. Ocular dominance was determined using the active measurement protocol proposed by Laby and Kirschen (2011), considered the most comprehensive for assessing ocular dominance (Moreno et al., 2022). In this protocol, participants were asked to extend their arms forward at face height, with their hands together and palms facing forward, leaving a small opening between the thumbs and index fingers of both hands.

Table 1
Descriptive characteristics of the study sample

		Total	Males	Females
		<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Gender		173 (100)	96 (55.49)	77 (44.51)
Backhand	One-handed	8 (4.62)	5 (5.21)	3 (3.90)
	Two-handed	165 (95.38)	91 (94.79)	74 (96.10)
Manual laterality	Right-handed	165 (95.38)	92 (95.83)	73 (94.81)
	Left-handed	8 (4.62)	4 (4.17)	4 (5.19)
		Mean (SD) Minimum; Maximum	Mean (SD) Minimum; Maximum	Mean (SD) Minimum; Maximum
Age		15.83 (2.86) 11; 23	15.58 (2.98) 11; 23	16.14 (2.70) 12; 22
Years of practice		10.06 (3.84) 3; 20	9.86 (4.05) 3; 20	10.30 (3.57) 4; 19

Figure 1

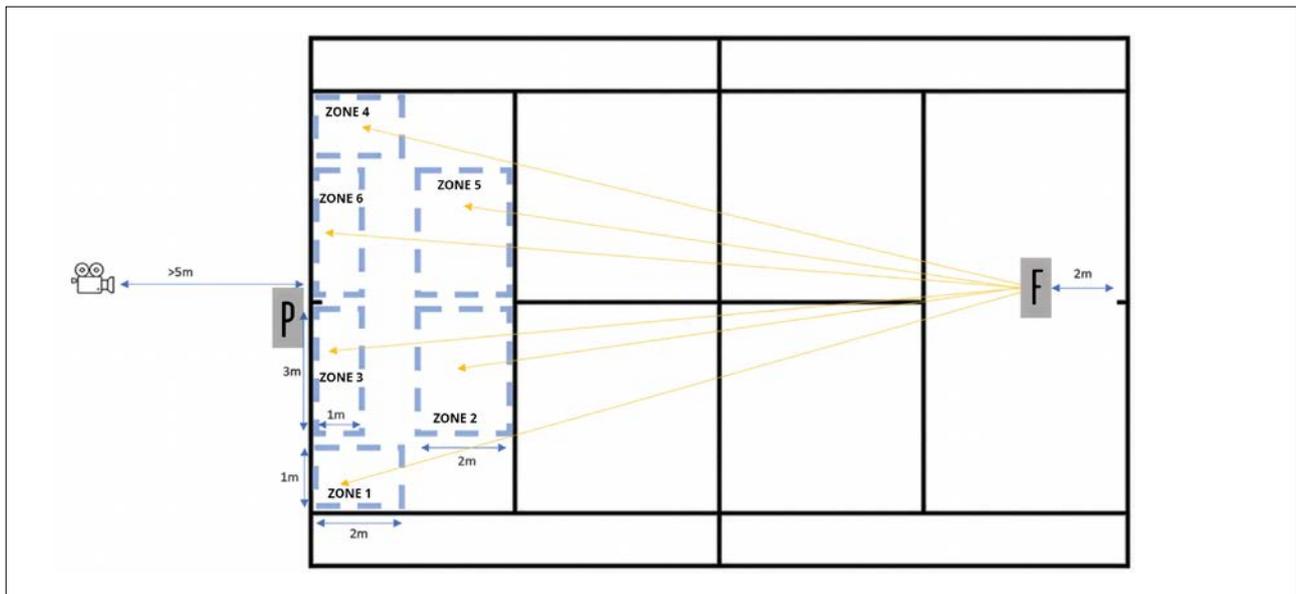
Ocular dominance test (start and end with a right-eye outcome)



Note. Reproduced with permission from the authors of the book *Nuevas tendencias en el entrenamiento del tenis: modelo basado en la acción de juego*, by Moreno and Baiget (2024).

Figure 2

Footwork preference test in tennis



Note. P: player; F: feeder.

With both eyes open, they had to focus through this opening on the evaluator's nose tip or camera lens, located 3 meters away. They were then instructed to bring their hands toward their face while keeping the target in focus at all times, so that the opening aligned with the dominant eye, thereby indicating ocular laterality (Knudson & Kluka, 1997). The test was performed three times, and the dominant eye was determined when the same eye was aligned in all three trials (Figure 1).

Finally, each player's profile was classified according to whether hand laterality (direct observation) and eye laterality coincided (UC-HELP) or did not coincide (C-HELP).

Protocol for Assessing Footwork Preference in Tennis

A purpose-designed test, routinely used by the Catalan Tennis Federation, was applied to assess footwork in a subsample of participants ($n = 61$). The protocol was video recorded and diagrammed, with zones and subzones detailed in Figure 2. Players started from the initial position (P), standing on the service line at the back of the court. A feeder, positioned 2 meters inside the baseline toward the net and aligned with the center of the court, hit the ball with the racket toward the corresponding zone. To standardize the test and ensure that players performed the intended movements, specific court

zones were marked where the feeder's ball had to bounce. When the ball did not bounce in the designated zone, the trial was repeated.

Regarding the general description of the protocol and execution conditions, players hit the ball ensuring that it landed within the boundaries of the opposite court while maintaining maximum realism in stroke execution. They were instructed to direct the ball cross-court or to the center of the court in strokes with lateral and backward movements (defense), and down the line in strokes with forward movements (attack), as these are the most logical directions according to game action (Moreno & Baiget, 2024). Each series included 3 repetitions, with the ball bouncing in the corresponding zone in each trial. All 3 trials were recorded to determine the predominant type of support. The protocol for assessing the technical fundamentals of the forehand and backhand strokes was as follows:

Lateral movement for forehand stroke. Lateral movement for forehand stroke. The feeder sent a ball that bounced in zone 1, requiring the player to move laterally 3 or 4 meters before executing a cross-court or central forehand (3 repetitions).

Forward movement for forehand stroke. The feeder sent a ball that bounced in zone 2, requiring the player to move forward 2 or 3 meters before hitting a down-the-line forehand (3 repetitions).

Backward movement for forehand stroke. The feeder sent a ball that bounced in zone 3, requiring the player to move backward 2 meters before executing a cross-court or central forehand (3 repetitions).

Lateral movement for backhand stroke. The feeder sent a ball that bounced in zone 4, requiring the player to move laterally 3 or 4 meters before executing a cross-court or central backhand (3 repetitions).

Forward movement for backhand stroke. The feeder sent a ball that bounced in zone 5, requiring the player to move forward 2 or 3 meters before hitting a down-the-line backhand (3 repetitions).

Backward movement for backhand stroke. The feeder sent a ball that bounced in zone 6, requiring the player to move backward 2 meters before executing a cross-court or central backhand (3 repetitions).

Regarding the description of the technical fundamentals of the type of support, for each ball hit to the designated zone, the type of support used by the player at impact was recorded. According to the categories established by Moreno and Baiget (2024), the technical fundamentals of the type of support (Figure 3) were as follows:

Open stance (O). At impact, the line of the hips was parallel to the net. The outside foot typically rotated externally.

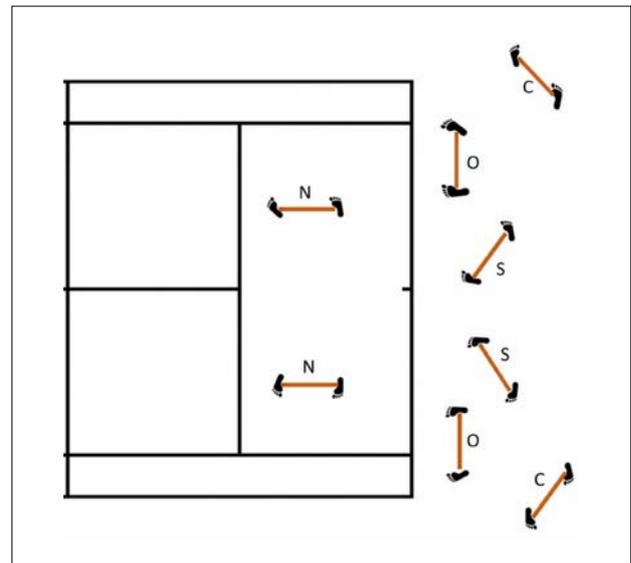
Semi-open stance (S). At impact, the line of the hips was diagonal and turned away from the net. The front foot pointed toward the net, whereas the back foot was oriented laterally.

Neutral or side-on stance (N). At impact, the line of the hips was perpendicular to the net and the feet were parallel to it.

Closed stance (C). At impact, the line of the hips was diagonal and turned away from the net.

Figure 3

Foot positions in forehand and backhand stances in tennis



Note. N: neutral; O: open; S: semi-open; C: closed. Reproduced with permission from the authors of the book *Nuevas tendencias en el entrenamiento del tenis: modelo basado en la acción de juego*, by Moreno and Baiget (2024).

Data Analysis

Cohen's kappa statistic (Cohen, 1960) was calculated to analyze test-retest and inter-rater reliability for the test used to determine the hand-eye laterality profile (classified as C-HELP or UC-HELP) and for the footwork preference test in tennis players (classified as closed, neutral, open, or semi-open), following the interpretation criteria proposed by Landis and Koch (1977): poor (< .20), fair (.21-.40), moderate (.41-.60), substantial (.61-.80), and almost perfect (.81-1.0).

For each of the six strokes with movement assessed (forehand lateral, forward, and backward; and backhand lateral, forward, and backward), the X^2 statistic (Pearson, 1900) was calculated to analyze the statistical significance of differences in the distributions of the four types of support between players classified with C-HELP and UC-HELP hand-eye laterality profiles.

Results

Study of the Reliability of the Hand-Eye Dominance Test

First, test-retest reliability of the hand-eye dominance test was analyzed to determine the hand-eye laterality profile in a subsample of tennis players ($n = 97$), one month after the initial test. Second, inter-rater reliability was analyzed in another subsample of players ($n = 69$). Both analyses showed high reliability, with 94.8% agreement (Kappa = .892; 95% CI: .799, .986; $p < .001$) in the test-retest analysis and 100% agreement between raters (Kappa = 1; $p < .001$) (Table 2).

Study of the Reliability of the Footwork Preference Test in Tennis

To analyze the reliability of the footwork preference test, an instrument used by the Catalan Tennis Federation, a retest was conducted by having a second rater review the video

recordings, following the same procedure as the first rater. For forward forehand supports, perfect agreement of 100% was obtained (Kappa = 1; $p < .001$). For lateral forehand supports, agreement was 98.4% (Kappa = .946; 95% CI: .839, 1; $p < .001$). For backward forehand supports, agreement was 98.4% (Kappa = .941; 95% CI: .819, 1; $p < .001$). For forward backhand supports, agreement was 91.8% (Kappa = .826; 95% CI: .691, .973; $p < .001$). For lateral backhand supports, agreement was 100% (Kappa = 1; $p < .001$). Finally, agreement for backward backhand supports was 91.7% (Kappa = .826; 95% CI: .676, .981; $p < .001$).

Distribution of HELP Profiles

Based on the hand-eye dominance test, the distribution of laterality profiles was analyzed in the total sample of high-level tennis players ($n = 173$). Overall, 42.2% of participants were classified as C-HELP (73 players) and 57.8% as UC-HELP (100 players) (Table 2).

Table 2

Preferred foot positions based on stroke, type of movement, and hand-eye laterality profile

Stroke	Movement	Foot position in supports	% C-HELP	% UC-HELP	% Total position	χ^2 (p)	
Forehand	Lateral	C	12.5	0	4.9	18.4 ($< .001$)	
		N	20.8	0	8.2		
		O	58.3	100	83.6		
		S	4.2	0	1.6		
		ud	4.2	0	1.6		
	Forward	N	48.6	16.7	27.7	7.46 ($< .006$)	
		S	51.4	83.3	72.3		
		Backward	C	16.7	0		6.6
			N	20.8	0		8.2
			O	0	2.7		1.6
S	62.5	97.3	83.6				
Backhand	Lateral	C	4.2	32.4	21.3	19.7 ($< .001$)	
		N	8.3	32.4	23		
		O	87.5	29.7	52.5		
		S	0	5.4	3.3		
		Forward	C	4.2	5.4		4.9
	N		58.3	62.2	60.7		
	O		37.5	29.7	32.8		
	S		0	2.7	1.6		
	Backward		C	20.8	10.8	14.8	3.08 ($< .380$)
		N	16.7	8.1	11.5		
O		0	2.7	1.6			
S		62.5	78.4	72.1			

Note. C-HELP: crossed hand-eye laterality profile; UC-HELP: homogeneous hand-eye laterality profile; C: closed foot position; N: neutral foot position; O: open foot position; S: semi-open foot position; ud: undefined foot position.

Preferred Foot Position Based on Hand-Eye Laterality Profile

Forehand stroke with lateral movement

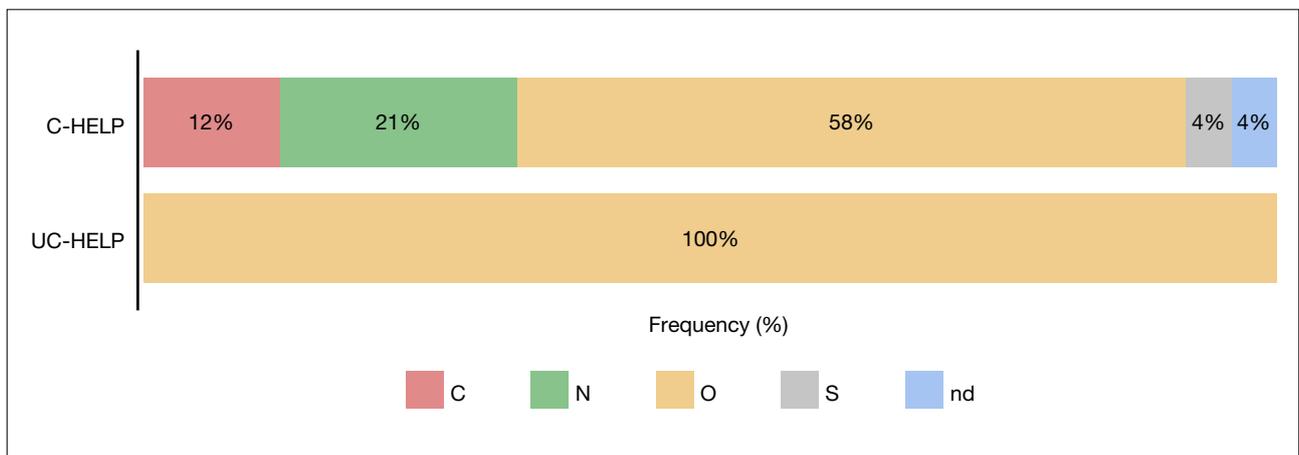
In forehand strokes with lateral movement, UC-HELP players showed a clear preference for the open stance (O): they adopted it in 100% of cases. In contrast, C-HELP players displayed greater variability in their positions, although the open stance (O) was still the most common, at 58.3%. The data also revealed that 4.2% of C-HELP players adopted an undefined position, varying their support across trials (Figure 4). These differences in the distributions of positions adopted by C-HELP

and UC-HELP players were statistically significant (Table 2).

Backhand stroke with lateral movement

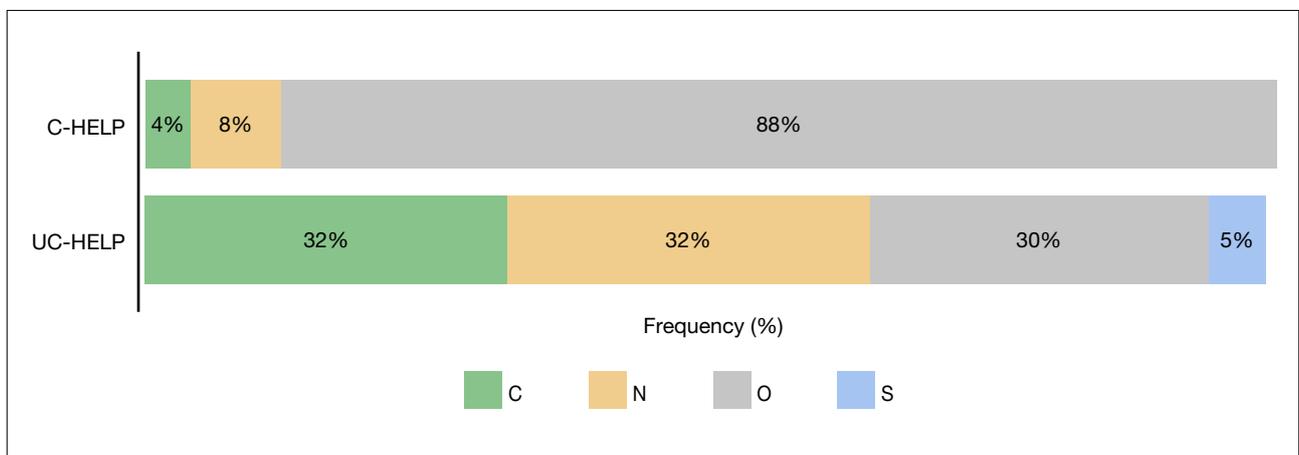
For backhand strokes with lateral movement, C-HELP players also showed a clear preference for the open stance (O), adopting it in 87.5% of cases (Figure 5), compared with only 29.7% of UC-HELP players. UC-HELP players displayed greater variability in their positions, with the neutral (N) and closed (C) stances being the most frequent, each accounting for 32.4% (Figure 5). These differences in the distributions of positions adopted by C-HELP and UC-HELP players were statistically significant (Table 2).

Figure 4
Distribution of preferred foot positions in the forehand stroke with lateral movement



Note. C-HELP: crossed hand-eye laterality profile; UC-HELP: homogeneous hand-eye laterality profile; C: closed foot position; N: neutral foot position; O: open foot position; S: semi-open foot position; ud: undefined foot position.

Figure 5
Distribution of preferred foot positions in the backhand stroke with lateral movement



Note. C-HELP: crossed hand-eye laterality profile; UC-HELP: homogeneous hand-eye laterality profile; C: closed foot position; N: neutral foot position; O: open foot position; S: semi-open foot position.

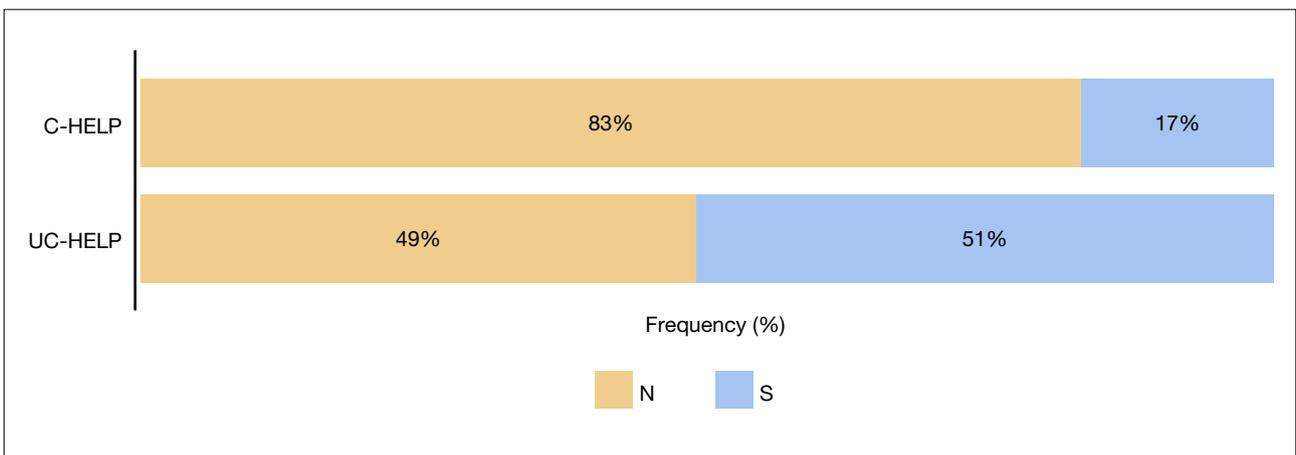
Forehand stroke with forward movement

In forward movements for the forehand stroke, C-HELP players showed an almost even distribution between the neutral stance (N) (48.6%) and the semi-open stance (S) (51.4%). In contrast, UC-HELP players more frequently adopted the semi-open stance (S) (83.3%), which may be related to the need for greater body rotation toward the dominant eye (Figure 6). These differences in the distributions of positions adopted by C-HELP and UC-HELP players were statistically significant (Table 2).

Forehand stroke with backward movement

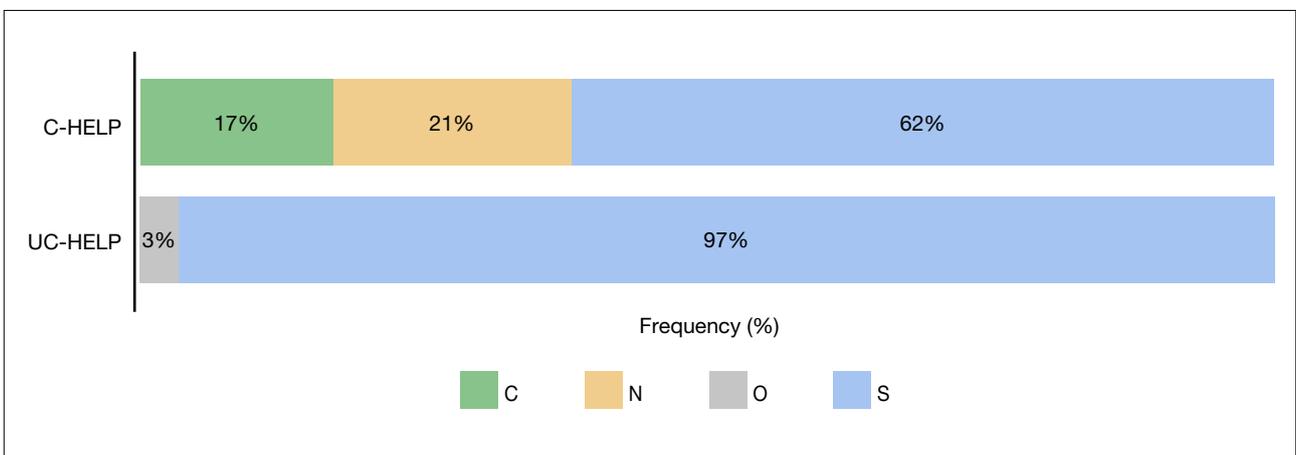
For the forehand stroke with backward movement, both C-HELP and UC-HELP players tended to use the semi-open stance (S), although with notable differences. UC-HELP players showed a highly consistent use of the semi-open stance (S) (97.3%), whereas C-HELP players adopted a range of stances: closed (C) (16.7%), neutral (N) (20.8%), and semi-open (S) (62.5%) (Figure 7). These differences in the distributions of positions adopted by C-HELP and UC-HELP players were statistically significant (Table 2).

Figure 6
Distribution of preferred foot positions in the forehand stroke with forward movement



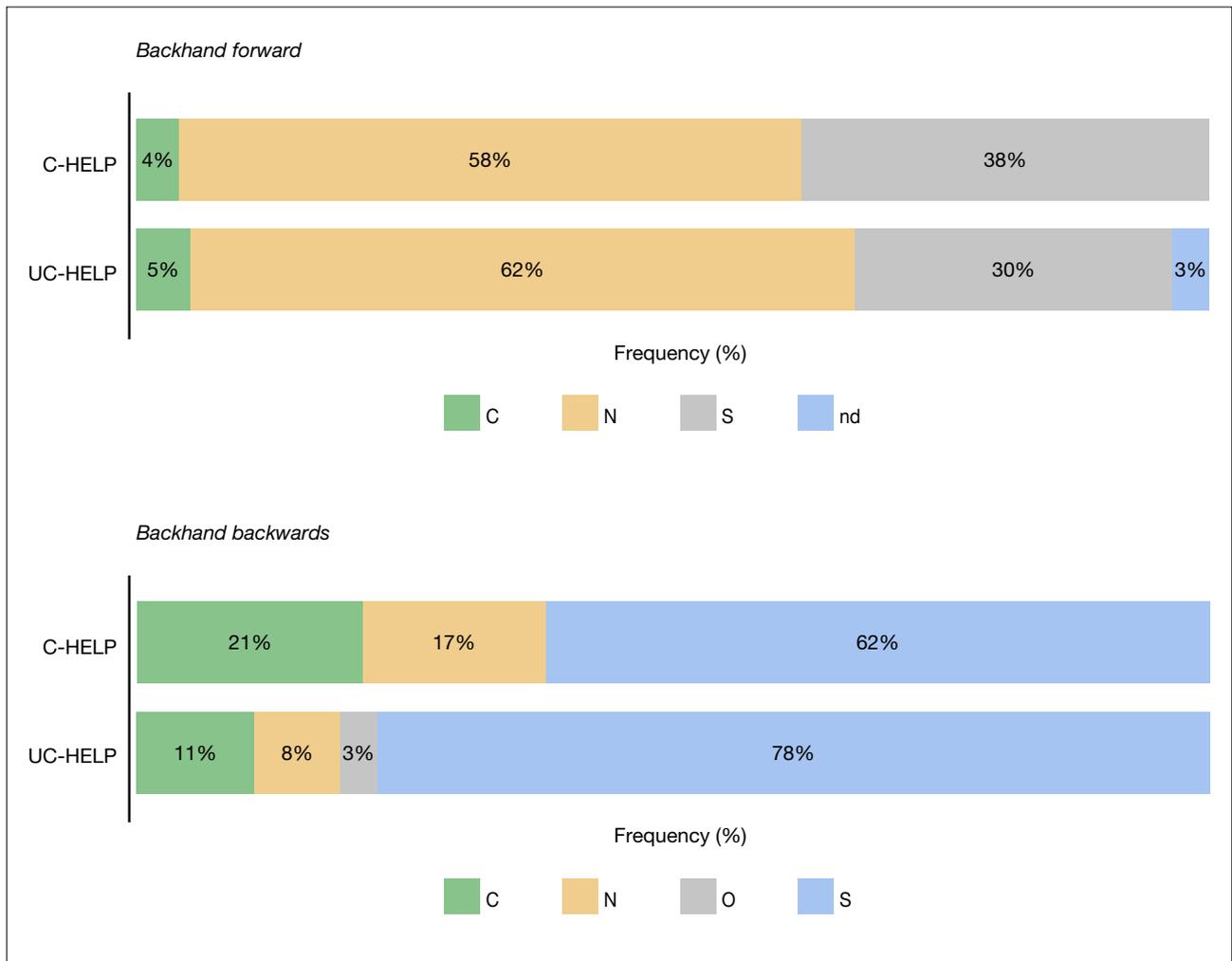
Note. C-HELP: crossed hand-eye laterality profile; UC-HELP: homogeneous hand-eye laterality profile; N: neutral foot position; S: semi-open foot position.

Figure 7
Distribution of preferred foot positions in the forehand stroke with backward movement



Note. C-HELP: crossed hand-eye laterality profile; UC-HELP: homogeneous hand-eye laterality profile; C: closed foot position; N: neutral foot position; O: open foot position; S: semi-open foot position.

Figure 8
Distribution of preferred foot positions in the backhand stroke with forward and backward movement



Note. C-HELP: crossed hand-eye laterality profile; UC-HELP: homogeneous hand-eye laterality profile; C: closed foot position; N: neutral foot position; O: open foot position; S: semi-open foot position.

Backhand stroke with forward and backward movement

In backhand strokes with forward and backward movement, the data indicated a general preference for the neutral stance (N) in forward movements (60.7%) and the semi-open stance (S) in backward movements (72.1%) (Figure 8), with no statistically significant differences between C-HELP and UC-HELP profiles (Table 2).

Discussion

This study met its objective of analyzing the reliability of two tests applied in tennis: the HELP assessment test (Laby & Kirschen, 2011; Moreno et al., 2022) and the footwork preference test, based on the instrument used by the Catalan Tennis Federation. Specifically, test-retest and inter-rater

reliability of the HELP test were examined, revealing a high level of agreement across time points and between observers. Reliability of the footwork preference test was also analyzed, with high agreement between measurements. In addition, the distribution of HELP profiles was examined in a sample of high-level tennis players, revealing a higher prevalence of crossed profiles (C-HELP) compared with the general population. Finally, the relationship between HELP profile and footwork preferences was explored, revealing specific patterns based on hand-eye laterality. The results are relevant from an applied perspective because the sample comprised players selected by the Catalan Tennis Federation according to level and performance criteria, making it representative of high-level developmental tennis at the regional level and with implications at the national and international levels.

The results for the HELP test demonstrate test-retest reliability in measurements made by the same evaluator at different time points. Furthermore, 100% agreement was obtained for inter-rater reliability. Overall, the HELP test can be considered reliable for assessing hand-eye laterality in tennis players. The relevance of these findings lies in the fact that, for the first time, evidence is provided on the reliability of a standardized protocol for measuring hand-eye laterality in sport. So far, methods used have been inconsistent, with considerable variability in tests for measuring ocular dominance and debate regarding which tests provide accurate assessment of this phenomenon (Bourassa et al., 1999; Laby & Kirschen, 2011; Moreno et al., 2022). In this regard, our results support the use of the proposed test to identify laterality profiles in tennis and other sports.

The footwork preference test showed agreement levels above 90%, and can therefore also be considered suitable for establishing technical profiles of footwork based on laterality and prior movement.

Regarding HELP profile, 42.2% of the tennis players assessed presented a C-HELP profile, indicating a higher concentration than in the general population, where the prevalence of this profile ranges from 10% to 30% (Robinson et al., 1997). This finding is consistent with previous studies that have examined laterality in elite tennis, such as Dallas et al. (2018), who reported 42% C-HELP among the world's best tennis players. Crossed hand-eye laterality may therefore represent an advantage for performance in tennis. However, further research is needed to provide evidence for this relationship and to clarify the underlying mechanisms. For example, Azémar (2003) suggested that reaction times may be faster for the hand contralateral to the dominant eye in laboratory tasks, which could influence the effectiveness of movements on court, and similarly, Balci et al. (2021) found faster reaction times in UC-HELP swimmers when the contralateral eye remained open. Therefore, the results are consistent with previous studies highlighting the influence of the relationship between ocular and motor laterality on sport movements (Castañer et al., 2016).

Analysis of support preferences by type of movement confirms the existence of distinct patterns based on hand-eye laterality profile. Our results show that the two profiles differ significantly in support preferences for forehand strokes (forward, backward, and lateral) and for backhand strokes with lateral movement. UC-HELP players tend to orient their bodies more frontally in the forehand stroke, whereas C-HELP players prefer open stances in the backhand stroke when moving laterally. This phenomenon is consistent with the observations of Garipuy and Wolff (1999), who suggested that

body alignment at impact is influenced by visual dominance, which acts as the player's perceptual-motor center. Thus, a right-handed player with a dominant right eye can more effectively coordinate the reception of a moving ball to the right side using a frontal stance, whereas in situations where the ball is directed to the left side, the player tends to rotate the body to optimize perception and stroke control. Likewise, players with a C-HELP profile show a greater preference for open stances when performing backhand strokes with lateral movements, whereas they more frequently adopt neutral and semi-open stances in forehand strokes.

These findings provide evidence of the influence of HELP on tennis players'™ motor organization and reinforce the importance of individualizing technical instruction in tennis by adjusting footwork patterns to optimize stroke biomechanics according to HELP profile and each player's perceptual-motor characteristics.

Conclusions

This study provides evidence for the reliability of the HELP test and the footwork preference test in tennis players and confirms the importance of assessing HELP profile because of its impact on the technical fundamentals of tennis. The results suggest that the hand-eye dominance test is a non-invasive tool that is easy to administer and requires no instruments, and that it may be highly useful in sport and in any context where hand-eye dominance is relevant. Its inclusion in routines for assessing technical aspects of tennis players is therefore recommended, as well as in athletes for whom laterality and hand-eye dominance may be an important factor.

The results obtained in a sample of high-level tennis players are notable for the significant prevalence of the crossed hand-eye laterality profile (C-HELP), at 42.2%, higher than the 10%–30% observed in the general population. This finding supports the idea that C-HELP profiles are over-represented among elite athletes in certain sports such as tennis, as suggested in previous research. In addition, a consistent relationship was identified between HELP and preferences in technical footwork patterns in tennis, specifically in foot position during strokes, with open stances being more common in forehands among UC-HELP players and in backhands among C-HELP players, particularly when balls are hit after lateral movement.

Although we underscore the reliability of the tests used and the inclusion of a large, representative sample of high-level developmental tennis players, it would be valuable to replicate our results with other samples of tennis players, both nationally and internationally, and with older and more advanced players. In our study, the sample was one of convenience, selected by

the Catalan Tennis Federation, and the aim was not to analyze differences by gender or manual laterality (right-handed/left-handed), as this would require prior hypotheses and a larger and more segmented sample. Nonetheless, we consider that such analyses represent a relevant line of research to be pursued in the future. The higher prevalence of C-HELP profiles observed among high-level tennis players does not explain the mechanisms underlying this relationship, and further research is needed in this direction.

Future research should also explore the role of other variables, such as perceptual–motor processing speed or decision making in tennis. Likewise, future studies should analyze stroke accuracy based on type of support and laterality profile and examine whether tailoring training to HELP profile can facilitate technical learning and help reduce injury risk, taking into account the potential relationship between certain support patterns and joint overload.

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Investigative Teaching in Physical Education and Sport Teacher Training

Arnoldo Alfonzo-Marín^{1*} , Javier Cachón-Zagalaz² , Lázaro Enríquez³  & Óscar DelCastillo-Andrés⁴ 

¹ PhD in Educational Innovation and Teacher Training, University of Jaén, Andalucía (Spain), Professor at the School of Physical Education, Sports, and Recreation, Faculty of Education Sciences, Technical University of Manabí (Ecuador).

² PhD in Sport Sciences for University of Jaén and PhD in Education for University of Granada. CU from Area of Didactics of Corporal Expression, University of Jaen, Andalucía (Spain).

³ Professor at the School of Physical Education, Sports, and Recreation, Faculty of Education Sciences, Technical University of Manabí (Ecuador).

⁴ Department of Physical Education and Sport, University of Seville, Andalucía (Spain).



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Abstract

The development of research skills in Physical Education (PE) and Sport (S) teachers is crucial for their professional development and for improving the educational process. This study, using a mixed approach and exploratory-descriptive design, aimed to diagnose the methods that teachers prioritize in the teaching of research within the training of PE and S teachers, as well as to evaluate the state of their research competencies. The ALCADE Research Competencies Form for teachers and structured interviews were used to analyze teachers' perceptions and practices. The data, processed using IBM SPSS and ATLAS.ti, revealed that 50% of the teachers involved in research training programs mainly use traditional methodologies, with an excessive emphasis on lectures and master classes, which contributes to students' passivity. These results highlight the urgency of contextualizing the teaching of research and adopting innovative methodologies in the training of Physical Education and Sport teachers, to create a more dynamic and effective didactic design.

Keywords: physical education, research, sport, teacher training, teaching methods

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*Corresponding author:

Arnoldo Alfonzo-Marín
aeam0002@red.ujaen.es

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Short track athlete in
mid-turn, with maximum
speed and focus on the ice.
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Introduction

Physical Education and Sport (PE and S) in Higher Education has traditionally focused on the study of physical movement skills, curricular planning, recreation, health-oriented free movements, sport pedagogy, sport training methods and elite sport. However, other authors emphasize the importance of studying processes that ensure robust training in research skills to develop competent teachers (Villaverde-Caramés et al., 2021). In this sense, Blázquez (2013) argues that the competency-based approach conceives the teacher as a person trained for both the organization and practical implementation of the subject (González et al., 2021). To this end, it is essential to inculcate research skills in future teachers to scientifically support their teaching (Nápoles, 2013).

The training of research skills in pre-service PE and S teachers is crucial for their academic and professional development (Arcos et al., 2020). Educational research has shown that research competence not only enriches the teaching-learning process but also drives the advancement of knowledge in the field. It is essential for applying theoretical knowledge in practical contexts, emphasizing the need for robust training in epistemology and research methods for future professionals (Chiva-Bartoll et al., 2018; Rodríguez & Reyes, 2020). Likewise, the role of advanced technologies, such as artificial intelligence, in research training has been highlighted for years, suggesting that their integration can significantly improve educational outcomes (Blasco & Pérez, 2007; Gavilanes et al., 2024).

Research training for future PE and S professionals depends not only on the acquisition of specific research knowledge but also on considering the political and institutional context of universities and their bureaucratic practices (Stylianou et al., 2017). Other findings highlight the importance of revisiting socio-critical research connected to transformative practice, considering open perspectives on inclusive education, and emphasizing technological changes, the use of lived histories, ethnography, and the experience provided by action research as a subjective and transcendental methodology (Felis-Anaya et al., 2017).

Action research is characterized as a highly reflective and participatory method of scientific research, ideal for the training of PE and S teachers (Keegan, 2016; Casey & Dyson, 2009). This approach is presented as a heuristic methodology that promotes a deep understanding of socio-

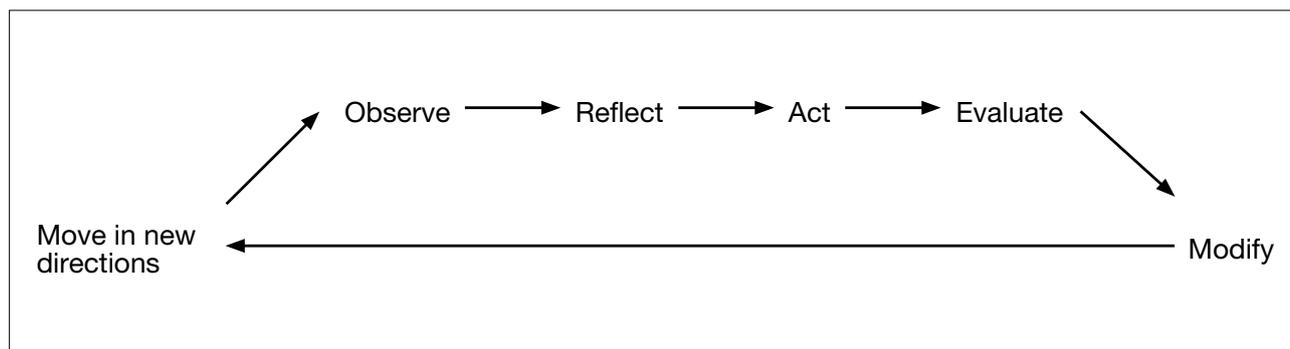
educational realities and practices, and their transformation. It positions educational actors as key agents in solving problems within their environments, combining theory and practice. This allows teachers to identify problems in their educational context, implement strategic interventions, and systematically evaluate the results. Action research is based on a cyclical process of planning, action, observation, and reflection, which facilitates continuous feedback and the ongoing improvement of pedagogical practice (Colmenares & Piñero, 2008).

Action research combines research with practical action, enabling teachers to identify specific problems in their work environment, implement innovative solutions, and systematically evaluate the results (Ryan, 2020). This approach not only improves the quality of teaching but also fosters a reflective and critical attitude in teachers, encouraging them to question and continuously improve their pedagogical methods. In the field of PE and S, where practices and needs may vary widely across different contexts, the ability to adapt and improve evidence-based teaching strategies is particularly valuable (Baños et al., 2021). This methodology empowers prospective teachers to actively engage in the process of developing pedagogical knowledge, rather than being mere recipients of external theories (Cárdenas-Velasco, 2023). This collaborative and participatory approach strengthens the educational community, promoting the exchange of experiences and effective practices among colleagues (Fernández y Johnson, 2015). In addition, it fosters a culture of continuous learning and professional improvement that can lead to significant innovations in the teaching of PE and S. To excite students about the study of research, it is necessary to provoke them to analyze problems that seem impossible (Galdames-Calderón et al., 2024). It is essential to ensure that students participate, question, and discuss in groups (León, 1996).

In action research, future teachers assume the role of researcher-practitioners (de Parra et al., 2018), which promotes participatory research, a process in which the actors involved actively collaborate in the generation of knowledge. Action research involves not only solving immediate challenges but also critically reflecting on practices to improve educational processes and foster a culture of inquiry among teachers. Action research requires a cycle of action and reflection (Oestar & Marzo, 2022).

A diagram of the action-reflection cycle (McNiff, 2009), describes the cycle with the following steps:

Figure 1
Action-Reflection Diagram in Action Research, Modified From McNiff (2009)



Observe: identify something that needs attention or improvement; Reflect: analyze what is happening in the process or practice; Act: implement an action based on the reflection; Evaluate: assess the results obtained from the action; Modify: adjust practices based on the evaluation; Move in new directions: based on the modifications, move forward with new approaches or strategies.

This cycle is continuous because, when a point is reached where things seem to improve, the process generates new questions, leading to the start of the cycle all over again. Reflection during action, and even reflection on reflection itself, are the best tools for meaningful learning. This approach calls for deep questioning of the reflective process itself (McNiff, (2017). It is applied in educational contexts to improve practice reflectively and consistently.

In contrast, action research promotes a culture of active collaboration among prospective teachers, encouraging the exchange of insights and the implementation of effective strategies to optimize performance and increase motivation (López-Vargas & Basto-Torrado, 2010). This differs markedly from traditional research approaches, where students tend to adopt a passive role (Vaughan et al., 2019).

The traditional teaching methodology in PE and S teacher education presents several negative characteristics (Stringer, 2010), which can limit the effective development of future teachers. First, this approach tends to be highly passive, emphasizing the unidirectional transmission of knowledge, where students receive information without actively participating in its construction. This can lead to a lack of involvement and motivation on the part of students, who become passive recipients rather than active participants in their learning process.

Another negative characteristic is the rigidity of traditional methodologies, which tend to follow a pre-established and uniform format without adapting to the specific needs of students or the particularities of the educational context. This lack of flexibility prevents the personalization of

learning and limits students' ability to develop the critical and creative skills needed in their future teaching practice. Additionally, traditional methodologies tend to focus on the memorization of concepts and the repetition of content. This lack of dynamic interaction and practical application prevents future teachers from fully experiencing and understanding the research process in depth.

Traditional methodology often relies on the memorization of concepts (Shi & Yang, 2023), rather than fostering practical application and critical thinking. Finally, traditional methodology may not be sufficient to prepare future teachers for the constant evolution of research in the field of PE and S. Contemporary research requires an adaptive and flexible approach that traditional methodology cannot always provide. In this regard, a study found that 16 universities in Shanxi use the traditional teaching model as their principal approach in PE (Galván-Cardoso & Siado-Ramos, 2021). Consequently, it concluded that it is essential to implement alternative educational models that diversify and modernize teaching in this field (Li-ping, 2009; Martínez-Alonzo & Román-Santana, 2025).

In the current context, the predominant use of traditional methodologies in the teaching of research presents several significant weaknesses, especially considering that this subject requires a practical and active approach. This passive approach may limit students' ability to experience and apply research methodologies in real contexts, which is crucial for the development of practical research skills. Another important weakness of traditional methodologies is the lack of contextualization of the examples provided by teachers. Often, the examples used in these methodologies do not relate to real or current situations in the field of PE and S. This disconnection between theory and practice makes it difficult for students to understand how to apply research principles in real scenarios. The main objective of this study was to diagnose the methods that teachers prioritize in the teaching of research within the training of PE and S teachers, as well as to evaluate the state of their research competencies.

Materials and Methods

The research was diagnostic-descriptive in nature. It was framed within a mixed (qualitative-quantitative) and cross-sectional approach. The ALCADE survey form, designed and validated by Marín et al. (2025), was applied. The survey was created using Google Forms 365 and distributed through various WhatsApp groups, where teachers of the relevant area were included. The validated questionnaire developed by Ríos Cabrera et al. (2023) was applied to measure research competencies in teachers (see Table 2). Additionally, a six-question structured interview was conducted to obtain a deeper understanding of participants' perceptions and teaching practices (see Table 3).

A non-probabilistic purposive snowball sampling method was used. We began by identifying an initial group of research teachers in PE and S, who were invited to participate in the study through a Zoom link to the webinar: "Perspectives in teaching research for PE and S teacher education". This link was distributed through WhatsApp groups. From this initial group, participants were asked to recommend other colleagues who also teach research in PE and S teacher education, resulting in a total of 28 participants.

Most surveyed professors were from Ecuador (60.7%), primarily aged 40–49 years (42.9%), with 11–20 years of experience (42.9%), and held a master's degree (71.4%). This reflects an experienced and academically qualified group of teachers in the field of PE and S research.

To explore university professors' perceptions of their pedagogical practices in teaching research within the context

of PE and S, a qualitative methodological approach was applied using semi-structured interviews. A set of six open-ended questions was designed to elicit reflective responses regarding didactic planning, the integration of theory and practice, the use of information and communication technologies (ICT), the promotion of student creativity, the contextualization of content, and the incorporation of real-field data from professional practice.

The interview questions were: (1) What is your conception and didactic design of the classes you teach? (2) How is the theory-practice balance in your classes? (3) What value or importance do you give to the use of ICTs in your classes, and how frequently do you use them? (4) How do you motivate and promote student creativity in your classes? (5) How do you select and adapt examples in your classes to ensure they align with the principles of PE and S? (6) Do you collect and analyze real-field data related to PE and S?

The compiled responses were analyzed using ATLAS.ti software through a thematic coding strategy, that enabled the identification of emerging categories and interpretive patterns. In addition, a word-frequency analysis was carried out to determine the most recurrent concepts and their association with the defined dimensions. This qualitative methodology allowed for an in-depth understanding of teaching practices and revealed the degree of alignment between theory, practice, and applied research in the professional training of PE and S instructors.

Table 1
Demographic Profile of the Surveyed Professors (n = 28)

Country	Age Range	Teaching Experience	Postgraduate Degree
Ecuador (60.7%)	30–39 years (35.7%)	5–10 years (39.3%)	Master's (71.4%)
Venezuela (21.4%)	40–49 years (42.9%)	11–20 years (42.9%)	
Mexico (7.1%)			
Peru (7.1%)			
Uruguay (3.6%)	50+ years (21.4%)	>20 years (17.8%)	Doctorate (28.6%)
Dominican Rep. (3.6%)			
Chile (3.6%)			

Table 2
Operationalization of Research Competencies in Teachers (Taken From Cabrera et al., 2023)

Dimension	Ability	Items
To pose the research problem	Detect topics or areas of interest that require scientific research	1
	Formulate the research problem	2
	Delimit the research problem	3
Construct the research frame of reference	Critically evaluate the state of knowledge in the area	4
	Build the research frame of reference	5
Designing the method	Specify the type of research	6
	Select the sample or informants	7
	Determine instruments and techniques for data collection	8
	Develop data collection instruments	10
	Incorporate information and communication technology resources	11
	Analyze quantitative data	12
	Analyze information using qualitative methods	13
	Apply mixed methods research	14
Communicate research results	Interpret key research findings	15
	Write academic or scientific reports	16
	Follow editing standards	17
	Draw conclusions	19
Verify scientific rigor and consistency between components	Formulate recommendations for future research	20
	Relate the components of the research	9
	Consider criteria of scientific rigor	18

Table 3
Operationalization of the Interview Questions

Dimension	Question (Q)	Q
Didactic design	What is the conception and didactic design of the classes you teach?	1
Theory-practice balance	How is the theory-practice balance in your classes?	2
Use of ICTs	What value or importance do you place on the use of ICT in your classes, and how often do you use it?	3
Encouraging creativity	How do you motivate and promote students' creativity in the classroom?	4
Examples in the context of PE and S	How do you select and adapt examples in your classes to ensure that they are aligned with the principles of Physical Education and Sport?	5
	Do you collect and analyze real-field data in Physical Education and Sport?	6

In this table, the key dimensions of the research process are broken down into specific skills, each associated with a corresponding item (Ríos-Cabrera et al., 2023). In the dimension of “Posing the research problem,” skills such as detecting issues of interest and formulating the problem, which are essential for establishing the focus of the research (items 1-3), are highlighted. The dimension “Constructing the research framework” involves critical skills for evaluating the state of knowledge and building a solid theoretical framework (items 4-5). The dimension “Designing the method,” involves technical skills such as specifying the type of research, selecting samples, obtaining data, and incorporating information technologies, addressing both quantitative and qualitative methods (items 6-15).

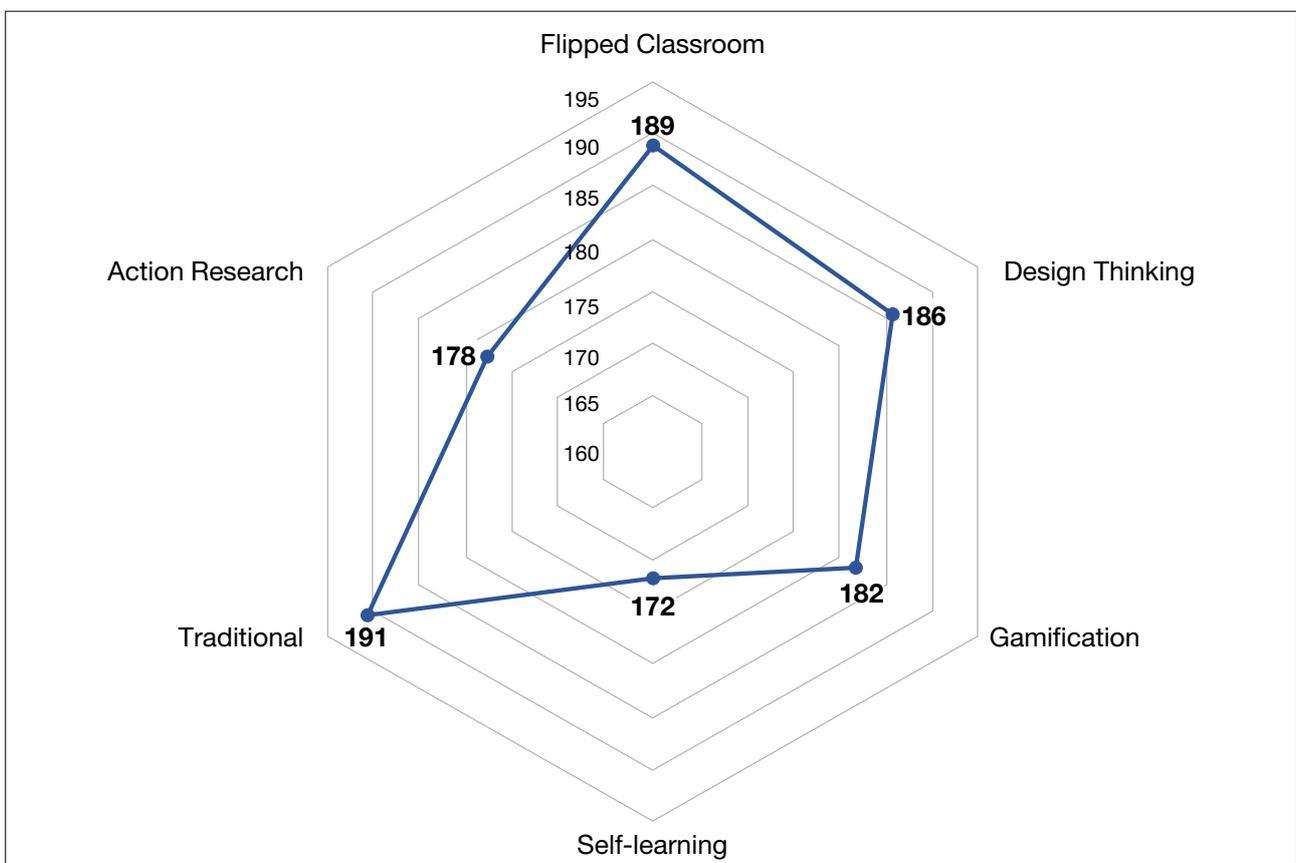
“Communicating research results” focuses on report writing and formulating conclusions, ensuring that results are presented clearly and coherently (items 16-20). Finally, the dimension “Verifying scientific rigor and coherence between components” addresses the critical evaluation of the internal coherence of the research, and the consideration of scientific rigor criteria, ensuring the validity and reliability of the study (items 9 and 18).

The operationalization of the questions made it possible to convert abstract pedagogical concepts into concrete and measurable variables. This process facilitated the objective measurement and analysis of teaching practices using clear categories that allow for a scientific interpretation of the data, ensuring coherence in the study.

Table 4
ALCADE Questionnaire

Teaching method	Frequency (<i>f</i>)	Minimum	Maximum	Average (\bar{x})	Standard Deviation (σ)
Flipped Classroom	189				
Design Thinking	186				
Gamification	182				
Self-learning	172	172	191	184.33	6.95
Action Research	178				
Traditional	191				

Figure 2
Radial Method Trend Graph



Results

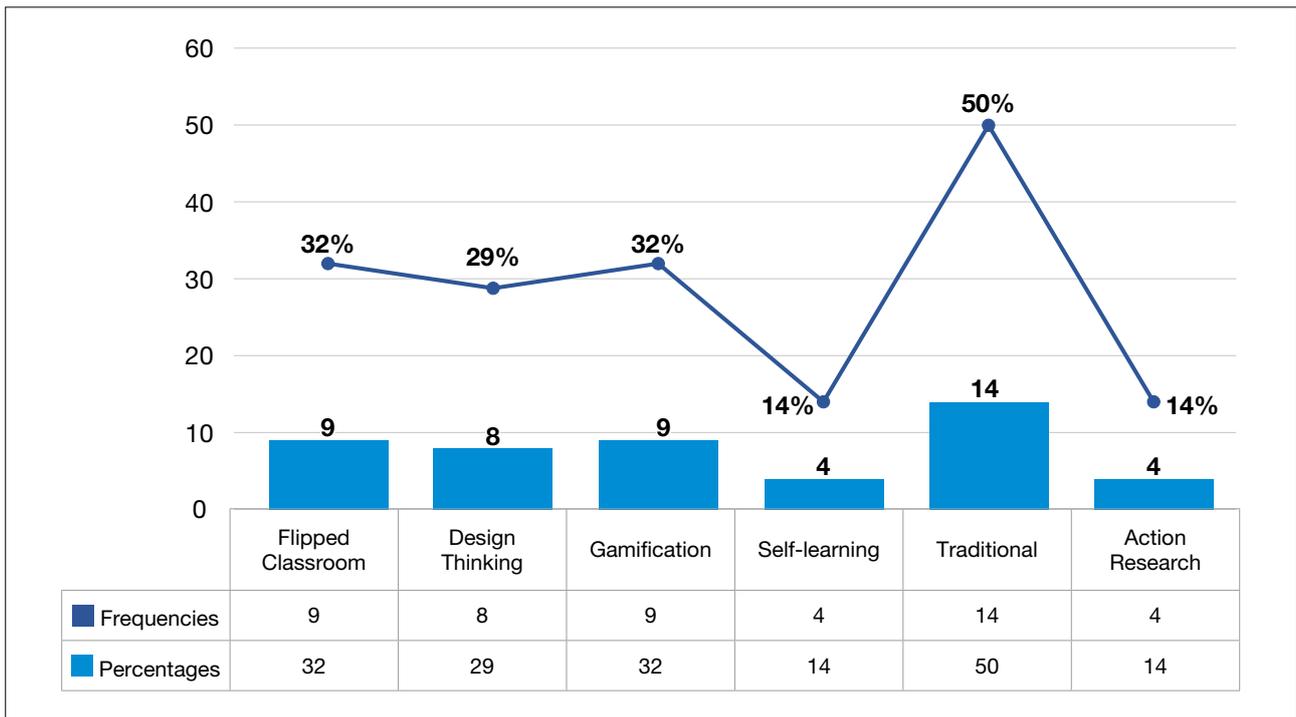
Survey Results

The range of 19 between the traditional method (191) and self-learning (172) reflects moderate variability in the frequency of use of these methods. The mean of 184.33 indicates that, overall, most teaching methods have a frequency above 180, suggesting a favorable trend toward their application. The median, with a value of 182.5, confirms that half of the methods exceed this frequency,

reinforcing their consistent use. The mode, corresponding to the traditional method (191), highlights its popularity and preference over the others (see Figure 2). Finally, the standard deviation of 6.95 indicates moderate dispersion, implying minor differences in the application of the various methods.

The graph shows the distribution of frequencies by method. The distribution, from lowest to highest frequency, is as follows: Self-learning (172), Action Research (178), Gamification (182), Design Thinking (186), Flipped Classroom (189) and Traditional (191).

Figure 3
Grouped Column and Line Graph of Frequency and Percentage of use of Teaching Methods



The graph shows the frequency and percentage of use of different teaching methods. Flipped Classroom and Gamification share the same frequency (9), which corresponds to 32% of use. Design Thinking has a slightly lower frequency

(8), representing 29% usage. Self-Learning and Action Research have the lowest frequency (4), accounting for only 14% of use. Traditional Method stands out with the highest frequency (14), representing 50% of use.

Table 5
Questionnaire of Research Competencies in University Teachers (Validated by Cabrera et al., 2023)

Descriptive statistics					
Ability	N	Minimum	Maximum	Average (\bar{x})	Standard Deviation (σ)
Detect topics or areas of interest that require scientific research	28	2	4	3.57	.634
Formulate the research problem	28	1	4	3.43	.790
Delimit the research problem	28	2	4	3.57	.690
Critically evaluate the state of knowledge in the area	28	1	4	3.46	.922
Build the research frame of reference	28	1	4	3.54	.881
Specify the type of research	28	1	4	3.54	.838
Select the sample or informants	28	2	4	3.61	.685
Determine instruments and techniques for data collection	28	2	4	3.61	.685
Relate the components of the research	28	2	4	3.61	.737
Develop data collection instruments	28	2	4	3.64	.731
Incorporate information and communication technology resources	28	2	4	3.75	.645
Analyze quantitative data	28	1	4	3.36	.951
Analyze information using qualitative methods	28	1	4	3.39	.916
Apply mixed methods research	28	1	4	3.43	.997
Interpret key research findings	28	2	4	3.64	.621
Write academic or scientific reports	28	2	4	3.64	.731
Follow editing standards	28	1	4	3.61	.832
Consider criteria of scientific rigor	28	1	4	3.43	.920
Draw conclusions	28	1	4	3.61	.786
Formulate recommendations for future research	28	2	4	3.64	.678
N valid (per list)	28				

Table 6
Correlation Between Dimensions

		Correlation				
		Research Problem Statement	Building the Research Frame of Reference	Designing the Method	Communicate Research Results	Verify Scientific Rigor and Consistency Between Components
Research problem statement	Pearson correlation	1	.833**	.819**	.863**	.804**
	Sig. (bilateral)		.000	.000	.000	.000
	N	28	28	28	28	28
Building the research frame of reference	Pearson correlation	.833**	1	.860**	.908**	.905**
	Sig. (bilateral)	.000		.000	.000	.000
	N	28	28	28	28	28
Designing the method	Pearson correlation	.819**	.860**	1	.881**	.880**
	Sig. (bilateral)	.000	.000		.000	.000
	N	28	28	28	28	28
Communicate research results	Pearson correlation	.863**	.908**	.881**	1	.921**
	Sig. (bilateral)	.000	.000	.000		.000
	N	28	28	28	28	28
Verify scientific rigor and consistency between components	Pearson correlation	.804**	.905**	.880**	.921**	1
	Sig. (bilateral)	.000	.000	.000	.000	
	N	28	28	28	28	28

** Correlation is significant at the 0.01 level (2-tailed).

The results obtained reflect a detailed evaluation of the teachers' research skills, with means ranging from 3.36 to 4.39, indicating moderate to high mastery of the competencies assessed. The best-evaluated areas include qualitative data analysis, specifically the ability to analyze interview and text responses using qualitative methods (mean = 4.39, standard deviation = .951), suggesting high proficiency in interpreting non-numerical data. Conversely, the skill with the lowest score was the development of instruments for data collection (mean = 3.36, standard deviation = .951), revealing a potential gap in the creation and validation of methodological tools.

Regarding data dispersion, the standard deviation ranges from .634 to .951, indicating moderate variability among participants. Although some skills show a homogeneous domain, such as the formulation of the research problem (mean = 3.57, standard deviation = .790), other skills present a greater dispersion, suggesting significant differences in the level of competence of the teachers evaluated. These results underline the need to reinforce certain key competencies in future training programs, especially in instrument development and methodological research design.

The Pearson correlation table reflects a strong interrelation among the fundamental aspects of the research. All variables—including formulation of research problems, development of the referential framework, methodological design, communication of results, and scientific rigor—show high correlation coefficients, ranging from .804 to .921, indicating highly significant relationships between them. The statistical significance in all cases is .000, confirming that these correlations are not due to chance and are significant at the 99% confidence level.

The strongest correlations are observed between communication of results and scientific rigor ($r = .921$), and between the referential framework and communication of results ($r = .908$). This provides evidence that teachers who show a high level of scientific rigor and construct robust referential frameworks tend to communicate their research results more effectively. Overall, the consistency of the relationships among the variables suggests that good performance in one key area of research is directly associated with high performance in other areas, reinforcing the importance of a comprehensive approach to research training.

Table 7
ATLAS. *ti*. Code-Document Analyses

Dimensions/ Value	Interview 1		Interview 2		Interview 3		Interview 4		Interview 5		Totals
	Absolute	Relative (%)	Absolute								
Theory-practice balance	60	23.90	29	18.83	52	24.19	61	28.24	27	14.92	229
Examples in the context of PE and S	59	23.51	42	27.27	64	29.77	55	25.46	49	27.07	269
Didactic design	62	24.70	25	16.23	41	19.07	43	19.91	31	17.13	202
Encouraging creativity	44	17.53	32	20.78	13	6.05	14	6.48	17	9.39	120
Use of ICTs	26	10.36	26	16.88	45	20.93	43	19.91	57	31.49	197
Totals	251	100.00	154	100.00	215	100.00	216	100.00	181	100.00	1,017

Table 8
Word Frequency Analysis ATLAS. *ti*

Words/ Values per Dimension	Total		Theory-Practice Balance		Context of PE and S		Didactic Design		Encouraging Creativity		Use of ICTs	
	Absolute	Relative (%)	Absolute	Relative (%)	Absolute	Relative (%)	Absolute	Relative (%)	Absolute	Relative (%)	Absolute	Relative (%)
Research	17	3.66	8	8.16	3	2.46	3	3.53	1	1.89	2	1.89
Students	16	3.45	1	1.02	6	4.92	3	3.53	4	7.55	2	1.89
Practice	10	2.15	8	8.16	1	0.82	1	1.18	0	0.00	0	0.00
Classes	8	1.72	0	0.00	2	1.64	5	5.88	0	0.00	1	0.94
Problems	8	1.72	0	0.00	3	2.46	0	0.00	5	9.43	0	0.00
Always	8	1.72	2	2.04	1	0.82	0	0.00	2	3.77	3	2.83
Learning	7	1.51	0	0.00	0	0.00	3	3.53	0	0.00	4	3.77
Real	7	1.51	0	0.00	2	1.64	0	0.00	5	9.43	0	0.00
Theory	7	1.51	7	7.14	0	0.00	0	0.00	0	0.00	0	0.00
Project	5	1.08	4	4.08	0	0.00	1	1.18	0	0.00	0	0.00
Subject	4	0.86	0	0.00	1	0.82	2	2.35	1	1.89	0	0.00
Sport	4	0.86	0	0.00	4	3.28	0	0.00	0	0.00	0	0.00
Education	4	0.86	0	0.00	2	1.64	0	0.00	2	3.77	0	0.00
Examples	4	0.86	1	1.02	3	2.46	0	0.00	0	0.00	0	0.00
Physics	4	0.86	0	0.00	2	1.64	0	0.00	2	3.77	0	0.00
Process	4	0.86	1	1.02	0	0.00	2	2.35	0	0.00	1	0.94
Zoom	4	0.86	0	0.00	0	.00	1	1.18	0	0.00	3	2.83
Know	3	0.65	0	0.00	3	2.46	0	0.00	0	0.00	0	0.00
Data	3	0.65	0	0.00	3	2.46	0	0.00	0	0.00	0	0.00
Elaboration	3	0.65	2	2.04	0	0.00	1	1.18	0	0.00	0	0.00
Structure	3	0.65	3	3.06	0	0.00	0	0.00	0	0.00	0	0.00
Practices	3	0.65	2	2.04	1	0.82	0	0.00	0	0.00	0	0.00
Realize	3	0.65	1	1.02	1	0.82	0	0.00	0	0.00	1	0.94
Theoretical	3	0.65	2	2.04	0	0.00	1	1.18	0	0.00	0	0.00
Tics	3	0.65	0	0.00	0	0.00	0	0.00	0	0.00	3	2.83
Work	3	0.65	1	1.02	0	0.00	0	0.00	2	3.77	0	0.00
Virtual	3	0.65	0	.00	0	0.00	0	0.00	1	1.89	2	1.89
Activities	2	0.43	1	1.02	0	0.00	0	0.00	0	0.00	1	0.94
Scientific Activities	2	0.43	0	0.00	0	0.00	0	0.00	0	0.00	2	1.89
Communication	2	0.43	0	0.00	0	0.00	0	0.00	0	0.00	2	1.89
Conception	2	0.43	0	0.00	0	0.00	2	2.35	0	0.00	0	0.00
Concepts	2	0.43	1	1.02	0	0.00	1	1.18	0	0.00	0	0.00
Knowledge	2	0.43	0	0.00	1	0.82	1	1.18	0	0.00	0	0.00

Interviews

The interview results reveal consistent patterns among university teachers regarding the design and delivery of research-oriented courses in Physical Education and Sport. Most participants reported structuring their classes with a strong emphasis on theoretical content, complemented by practical activities linked to the development of research projects—an approach they consider a balance between theory and practice—. As one teacher stated, “I maintain a 50/50 balance, where theory is immediately applied through practical exercises,” reflecting a perspective frequently shared among respondents. Similarly, the use of ICT was commonly valued as a key resource for accessing information and personalizing learning, with frequent use of tools such as Word, PowerPoint, and projectors. Regarding creativity, several teachers emphasized that it is encouraged by allowing students to identify and work on real problems within the context of Physical Education, as one participant noted: “I promote creativity by allowing students to express real issues in the context of physical education.” It was also commonly mentioned that examples and analytical situations are derived from students’ own experiences. However, a recurrent limitation identified was that the analysis of real-field data is not conducted during the course itself but is deferred to later stages under the guidance of academic advisors.

The analysis of the interviews reveals that the context of the EF and S, is the most prominent theme, with a total of 269 mentions and particularly high relevance in Interview 3 (29.77%). It is closely followed by the theoretical-practical balance, with 229 mentions (23.9% to 28.24% depending on the interview). Didactic design, accounted for 202 mentions (19.07% to 24.7%). The use of ICTs, with 197 mentions (10.36% to 31.49%), shows considerable variability among interviews, reaching its highest relevance in Interview 5. In contrast, the promotion of creativity, with 120 mentions (6.05% to 20.78%), was less frequently mentioned but remains a relevant theme.

The Word Frequency table of the interviews reflects the most recurrent words used during the interviews: The word “research” appeared 17 times. Other frequently mentioned words include “problem” (10 mentions) and “learning” (8 mentions), as well as “theory” (7 mentions) and “practice” (6 mentions). The terms “sport” and “physics” were each mentioned 4 times, while “project” appeared 5 times. Words such as “examples”, “virtual”, and “work” are associated with the use of technologies and practical approaches in the educational process, possibly reflecting the current context of digital or hybrid teaching. Words with 3 or fewer mentions, such as “scientific”, “theoretical”, and “knowledge”, were less prominent.

Discussion

The results of this study are in line with previous research highlighting the relevance of a sound theoretical framework and a clear definition of the research problem in teacher education (Chiva-Bartoll et al., 2018). A well-structured approach to methodological design and hypothesis formulation is crucial for the development of research competencies in the field of sports sciences (Rodríguez & Reyes, 2020). Properly posing research problems, constructing robust referential frameworks, selecting the correct methods, and effectively communicating research results with scientific rigor and coherence are key criteria for assessing research competencies in teachers and students (Marín et al., 2024), which coincides with the significant correlations observed between these variables in the study. Additionally, the integration of advanced technologies in research training is highly relevant, suggesting that such tools can enhance the teaching-learning process, an aspect that should be considered in future pedagogical proposals (Blasco & Pérez, 2007). Likewise, the strong correlation observed between the evaluation of results and scientific rigor confirms the findings of Stylianou et al. (2017), who emphasize that the research training of future professionals of PE and S depends not only on acquired competencies but also on the political and social context in which they are trained.

This research employed three key instruments that allowed for a comprehensive assessment of the research-teaching process in teacher education in PE and S. First, the ALCAD instrument was essential for capturing teachers’ perceptions of research-teaching methods, providing a robust quantitative framework for analysis. Second, the research competency questionnaire was used, which assessed teachers’ research competencies, providing detailed insight into their level of preparation and their ability to guide students in educational research. Finally, the structured interview allowed for the compilation of more in-depth qualitative data on teachers’ practices, facilitating the understanding of their perceptions and challenges in teaching research, and complementing the findings of the quantitative instruments.

The results obtained indicate the teaching methods most frequently prioritized by teachers in the instruction of research within PE and S teacher education. A significant tendency was observed toward the use of traditional methodologies, with a strong reliance on lectures and direct transmission of information. Figure 3 illustrates a clear preference for the traditional method, with a frequency of 50%, positioning it as the most commonly used among those evaluated, reflecting a conservative trend in teaching. The Flipped Classroom and Gamification methods each had a frequency of 32%, showing that they are popular, although not predominant, alternatives.

Design Thinking remains close with 29%, indicating moderate adoption. In contrast, the Self-Learning and Action Research methods, both with a frequency of 14%, evidence low implementation, suggesting that, according to the study sample, these more innovative approaches have not yet gained significant ground in inquiry-based teaching within PE and S teacher education.

Through correlational analysis, significant associations were identified between key aspects of research, such as problem formulation, methodological design, and the elaboration of the referential framework, suggesting a cohesive approach to research teaching and implying that teachers possess the necessary skills to be competent in research. The significant correlation between research competencies, research problem formulation, and scientific rigor ($r = .804, p < .01$) reflects an expected relationship according to the literature, where a clear and well-defined approach to problem formulation is a key indicator of rigor in research (Chiva-Bartoll et al., 2018). Furthermore, the strong correlation between the use of the referential framework and the quality of the results ($r = .908, p < .01$) underlines the importance of a well-constructed theoretical framework for the proper interpretation of findings. These results are aligned with previous studies that point out the need for a solid theoretical framework as a basis for research training in disciplines such as PE (Rodríguez & Reyes, 2020). The analysis of the interviews conducted with teachers revealed that the most outstanding dimensions were the theoretical-practical balance, didactic design and the use of ICTs—essential components in the teaching of research. These findings reinforce the need to combine these aspects of theoretical analysis with practice (Ryan, 2020) and to implement methodologies that empower future trainers in research practice (de Parra et al., 2018).

Limitations

One of the main limitations of the study is the sample size. With only 28 participating teachers, the findings may not be representative of the entire teaching population in the field of PE and S. However, due to the characteristics of the population, it is complex to recruit teachers with similar profiles to avoid selection bias. Finally, most of the innovative teaching methods, such as flipped classrooms, were not employed consistently, which precludes more detailed comparisons between traditional and innovative methods in terms of effectiveness in teaching inquiry skills.

The research by Cañadas et al. (2019), offers a valuable approach to Physical Education teachers' perceptions of the development of their key competencies during their initial training, while also highlighting the existing differences

related to their professional performance. Although the study presents a robust set of competencies as reported in the evaluation form, it is important to consider that the acquisition of research competencies is essential for strengthening and ensuring comprehensive professional practice. From a continuous improvement perspective, the ability to conduct research enables teachers to critically analyze their practice, adapt to changing contexts, and base their pedagogical decisions on evidence, thus effectively complementing the set of competencies evaluated in this study.

Ethical and Regulatory Compliance

This research was conducted in strict adherence to ethical principles and international standards on scientific integrity. The study followed the guidelines of the Code of Good Scientific Practices of the Spanish National Research Council (CSIC, 2021). Throughout the process, the autonomy, dignity, and rights of all participants were respected, promoting responsible, inclusive, and equitable research practices.

Methodological and ethical rigor was maintained through procedures designed to ensure the transparency, validity, and reproducibility of the study. The development and application of data compilation instruments were guided by the *Guide for Equal and Non-Sexist Use of Language and Images* from the University of Jaén, ensuring inclusive communication and equitable gender representation in all research materials, (U.N., 2022).

Prior to data collection, individual orientation sessions were held with each participant, during which the study's purpose, procedures, potential risks, and benefits were clearly explained. Written informed consent was obtained in compliance with ethical standards. All data were treated with strict confidentiality and anonymity and were used solely for academic and scientific purposes, in accordance with current data protection regulations and best practices in research ethics.

As part of our commitment to transparency and openness in science, the validation of the instrument used has been registered and documented on the Open Science Framework (OSF) platform, facilitating access for the scientific community and promoting the reproducibility of results. Retrieved from osf.io/vy7rt.

Conclusions

The study reveals a strong preference for traditional teaching methodologies in research instruction, characterized by a focus on direct content transmission and limited student engagement. This approach restricts the development of

critical thinking and reduces students' active involvement in the research process, which is essential for meaningful and reflective learning in Physical Education and Sport.

Despite teachers' theoretical knowledge of research methods, a gap persists between theory and practical implementation, particularly in the construction of research instruments. This limitation can hinder their ability to effectively guide students through rigorous and contextually relevant research processes.

The analysis of research competencies highlights that a well-structured theoretical foundation enhances the interpretation of findings and the formulation of sound conclusions. This reinforces the importance of scientific rigor and methodological coherence throughout all stages of research-based teaching.

Ultimately, the integration of active methodologies, such as action research, emerges as a key strategy to promote autonomy, critical reflection, and adaptability to contemporary pedagogical and research challenges in the training of future Physical Education and Sport professionals.

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