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PHYSICAL ACTIVITY AND HEALTH

LGTBIQA+, mental health and the sporting context: a systematic review

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Abstract

The majority of people who identify as lesbian, gay, trans, bisexual, intersex, queer and asexual experience some form of discrimination in the sporting environment, which increases the risk of developing mental health illnesses. The aim of this review is to provide an updated overview of the existence of LGBTIQA+ mental health conditions in the context of sport. As a search strategy, five databases were systematically searched for articles from 1996 to 2019: Web of Science, Scopus, PubMed, Sociological Abstracts and Eric. In the review, articles relating the three areas of study: factors associated with mental health, people belonging to sexual and gender minority groups, and the sporting context, were selected. Reviews and research in English and Spanish were included. The results were captured in a data collection table. A total of 2,081 records were retrieved in the first searches, of which 26 met the inclusion criteria. The articles were classified into three fields, according to the focus of the study: 1) experience and discrimination in sport, 2) prevention and inclusion, 3) perceptions and associations of gender, identity and sexual orientation in sport. Finally, in conclusion, a high prevalence of mental health problems in LGBTIQA+ people was identified as a result of experiences in hostile and LGTBIphobic environments within the sport context.

Keywords: discrimination, gender identity, LGTBIphobia, mental health, sexual orientation, sport.

Introduction

Almost 40% of the population belonging to a sexual minority group have experienced discrimination or bullying because of their sexuality (European Union Agency for Fundamental Rights, 2020). Bullying is a social phenomenon defined by repeated negative actions based on an imbalance of power between equals, whereby the more powerful individual attacks or bullies the less powerful individual with the intention of harming or offending them (Olweus, 1996). Thus, LGTBIphobia is discrimination based on an individual's real or perceived sexual orientation, with the intention of denigrating and devaluing (Baiocco et al., 2018). This discrimination causes social stress, especially among people belonging to stigmatised social groups. Continued discrimination requires adaptation through coping mechanisms that cause emotional repercussions and can cause mental health problems (Symons et al., 2017).

In the context of sport, discrimination against LGTBI (lesbian, gay, bisexual, trans-gender, intersex) people is intensified, as sport has historically been a space of male domination, reserved for hegemonic masculinity (heterosexuals, with high physical development and little emotional affectivity) (Serra et al., 2019). This domain explains the low participation of women and the rejection of homosexuality. Despite social change in contemporary societies, sport remains one of the most androcentric and hostile environments with regard to the presence of people from sexual minorities (Moscoso and Piedra, 2019). As a consequence, they often avoid the sporting context: out of 93,079 LGBT adults (over 18 years old) from 28 countries, almost half (42%) confessed that they avoid sports clubs out of fear of being assaulted, threatened or bullied because of their sexual orientation or gender identity (European Union Agency for Fundamental Rights, 2013).

When we focus on adults belonging to a sexual minority group, LGTBIphobia in the sporting context is a frequent social phenomenon, which causes discomfort for the people who are faced with it (Baiocco et al. 2018). In terms of recreational sport, trans-gender people prefer individual sports and activities to team sports and mainly jog, walk and practice hypertrophy training (López-Cañada et al., 2020).

In the professional context, according to Lee and Cunningham (2016), both coaches and athletes can face discrimination if they identify as LGBT or do not behave according to gender mandates. These prejudices can affect their attitudes and be relevant in the professional environment. According to Pronger (1999), competitive sport, as an immensely popular cultural practice and spectacle, plays an important role in the reproduction of gender stereotypes implicit in our patriarchal system, which is why it generates LGTBIphobic situations.

According to DeFoor et al. (2018), in the case of adolescents, behaviours specific to the sporting context often also cause harm, as this is the period of change during which identity and personality are defined, it is a time of instability and emotional vulnerability. Currently, there are still barriers to young people belonging to a sexual minority group's participation in sport, that prevent them from enriching themselves with the psychosocial benefits of participating in sport with other young people in the same way as their heterosexual peers (Doull et al. 2018).

According to Anders and DeVita's (2019) study, in physical education sessions, LGTBIQ+ student-athletes are twice as likely as their heterosexual counterparts to be bullied, ignored or deliberately excluded from team sport activities. This makes LGTBIQ people two to three times more likely to suffer from anxiety and depression and almost 14% will attempt self-harm or suicide (Turk, 2018).

Although scientific literature exists in relation to the mental illnesses that sexual minorities may suffer as a result of bullying and discriminatory experiences in the sporting context, no systematic review has yet been conducted that examines and links the three areas (mental health, the LGBTIQA+ community and the sporting context). Thus, the aim of this systematic review is to provide an updated overview of the existence of mental health conditions among LGBTIQA+ people in the context of sport. This was done by: a) finding out the percentage of articles related to mental health, people belonging to sexual minorities and the sporting context since the first publications on this topic in 1996, up until 2019; b) classifying the articles according to the author, the year of publication, the characteristics of the participants, the methodology used and the factors associated with mental health status; c) identifying the thematic areas to which the articles refer and classifying them according to these.

Methodology

This systematic review has identified, selected and critically appraised relevant information from the included studies. In order to maintain methodological rigour, the items defined by the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) statement have been applied. This constitutes a minimum set of evidence-based elements for reporting in systematic reviews and meta-analyses (PRISMA, 2021).

Search strategy

Five databases were consulted: Web of Science, Scopus, PubMed, Sociological Abstracts and Eric. Publications from 1996 to 2019 were systematically searched, using combinations of the terms: LGBTI, LGBT, gay, lesbian, bisexual, transsexual, trans-gender, intersex, asexual, sport, athlete, wellness, mental health, disorder, bullying; Anglo-

Saxon terms were used. Accepted keywords were detected in the Web of Science and Scopus databases and search history and search combination were used. In the Sociological Abstracts and Eric databases, the filter *sports* was used to determine the search items. The relationship between research terms, databases and articles found, discarded and selected is shown in Table 1.

Table 1
Database search strategies.

The research terms are reproduced verbatim as used in the database

Database	Research terms	Articles identified by database-specific search filters	Discarded articles	Selected articles
Eric	(Queer) AND (sport) AND ((mental health OR wellbeing OR bullying))	2	2	0
PubMed	LGTB OR (gay OR lesbian OR bisexual OR intersexual OR transsexual OR asexual OR queer) AND (athlete OR sport) AND (mental Health OR wellbeing)	129	124	5
Scopus	(LGTBI OR lesbian OR gay OR transsexual OR transgender OR bisexual OR intersexual) AND (sport OR athlete) AND (disorder OR wellbeing OR bullying)	26	18	8
Sociological Abstracts	S1. (lesbian OR gay OR transsexual OR bisexual OR intersexual) AND (sport OR athlete) AND ((mental health) OR (well-being))	26	32	1
	S2. transsexual AND sport AND bullying	3		
	S3. transgender AND sport AND bullying	4		
Web of Science CORE Collection	S1. (LGTBI OR lesbian OR gay OR transsexual OR transgender OR bisexual OR intersexual) AND (sport OR athlete) AND (mental health OR wellbeing)	50	52	12
	S2. (LGTBI OR lesbian OR gay OR transsexual OR transgender OR bisexual OR intersexual) AND (sport OR athlete) AND (bullying)	14		

Three stages (identification, screening and eligibility) were defined in the article selection process in order to identify the articles to be included in the review. Figure 1 shows the summary of the stages and the results of the research strategy.
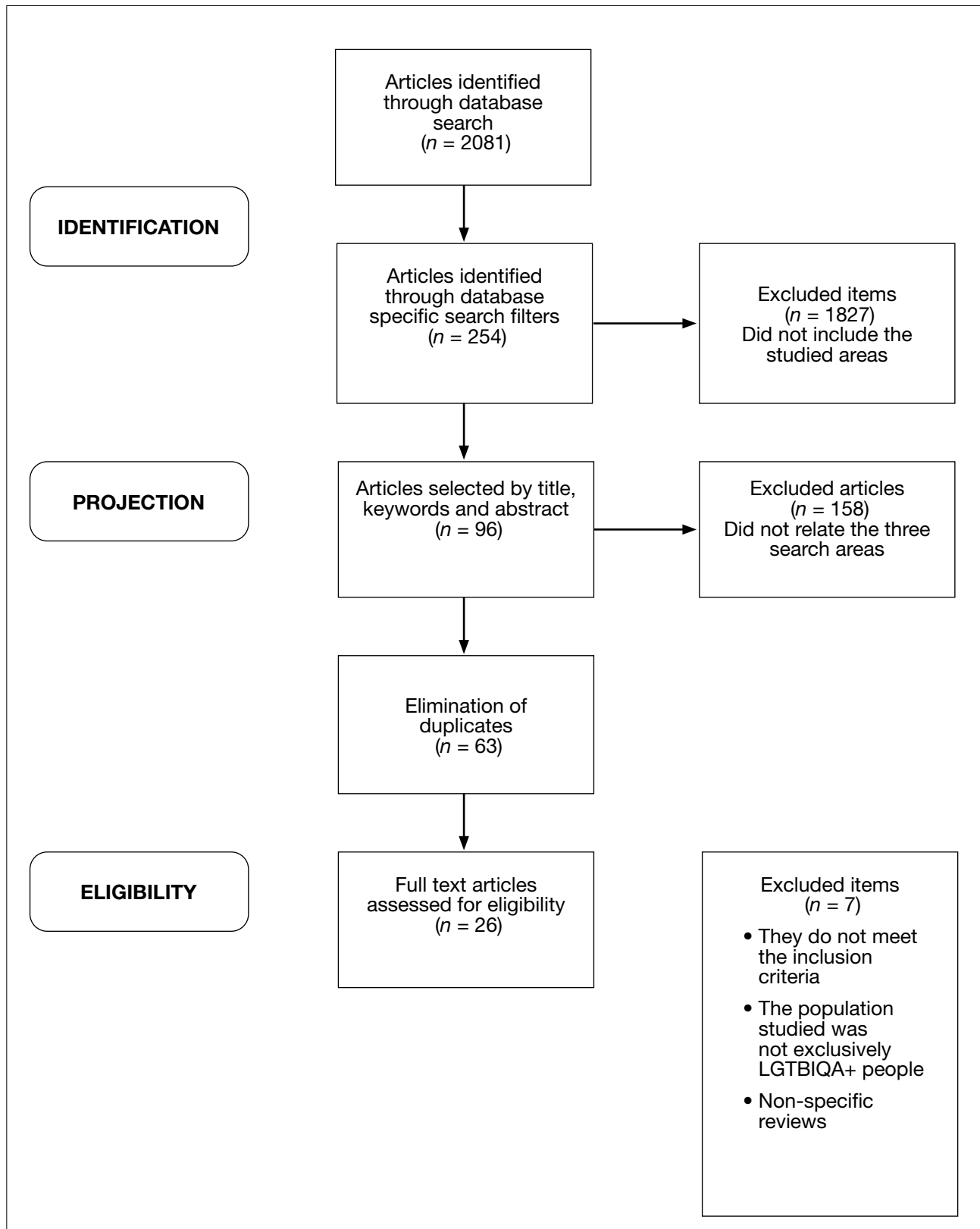

Figure 1
Stages and results of the search strategy using the PRISMA statement's own flow chart.

Table 2
Inclusion criteria for the literature searched.

Category	Criteria
Thematic area	1- Mental health, wellbeing, factors associated with mental health 2- LGTBIQA+ persons, sexual minorities 3- Sport, athletes, sporting context
Study population	Lesbian, gay, transsexual, trans-gender, bisexual, intersex, queer and asexual people People involved in sport who belong to sexual minority groups LGTBIQA+ students and/or adolescents Professional athletes from sexual minority groups Coaches from sexual minority groups Gender non-conforming people
Language	English and Spanish
Date of publication	Not an exclusion criterion (1996-2019)
Source type	Academic articles and theses
Publication criteria	Review articles and research

Eligibility criteria

To begin with, three areas of study were defined: factors related to mental health, sexual and gender minorities and the sporting context. Articles analysing one of these three areas were exported to the Mendeley bibliographic reference manager and duplicates were removed. From these, articles relating these three areas were selected and included in the review. Reviews and research written in English or Spanish with publication status: online publication, were included. Newspaper and magazine articles were excluded. In addition, articles that did not exclusively study LGTBIQA+ people were excluded. Date of publication was not an exclusion criterion. Table 2 shows the inclusion criteria used in the review.

Data collection

A data collection table was created to record authorship, titles, type of source and publication, study objective, fields, participants, method, intervention descriptions, factors associated with mental state and results. The most significant data was selected and reflected in Table 3 summary, presented in the results section.

Table 3
Summary of selected articles.

Author (year)	Type of source and publication	Journal and journal quality index	Field	Participants	Description of the research methodology	Factors associated with mental state
Anders and DeVita (2019)	Academic article Research (case study)	*International Journal of Qualitative Studies in Education* JCI[1]: 1.12	Perception and association of gender and sport (education)	DeVita, a gender non-conforming (GNC) student in high school	Qualitative. From the **analysis** of Butler's work on gender and **interviews** with a classical ballet coach and a football coach, the case of DeVita is analysed: a gender non-conforming student. The article examines how the student expresses their identity, expression, sexual orientation and masculinity.	Anxiety and discomfort
Atteberry-Ash et al. (2018)	Academic article Research	*Sexuality Research and Social Policy* JIF[2]: 3.618 JCI: 2.05	Perception and association of gender and sport (education)	Students aged 17-29, 51.7 % male, 95.9 % undergraduates (approx. 40,000 students)	Quantitative. **Cross-sectional study**: The data for this article was drawn from a study examining the experiences and perceptions of LGBT issues among students engaged in after-school sports programmes (*N* = 2495)	Discrimination
Baiocco et al. (2018)	Academic article Research	*Journal of Gay and Lesbian Mental Health* SJR[3]: 0.894	Experience and discrimination in sport (adults)	88 gay men and 120 heterosexual adult men between 18 and 36 years of age	Quantitative. **Questionnaire**: examines how often gay people have experienced bullying at school compared to their heterosexual peers in the context of sport in Italy.	Bullying and psychosocial problems
Block (2014)	Academic Article Review	*Quest* JIF: 2.910 JCI: 1.46	Experience and discrimination in sport (education)	LGBTQ students in the subject of physical education	Qualitative. Analyses the needs of LGBTQ youth in physical education sessions, relating them to Kleinman's phenomenological goals of physical education.	Psychosocial and medical problems
DeFoor et al. (2018)	Academic article Narrative review	*Sports Medicine - Open* JIF:11.136 JCI: 2.09	Prevention and inclusion (education)	LGB student-athletes	Qualitative. **Analysis**: 1- Vulnerability of the school environment 2- Non-inclusive heteronormative environment 3- Bullying and discrimination at home 4- Male and female athlete stereotypes 5- Prevalence of mental health problems and substance use 6- Making sport safer for future LGB generations	Welfare, bullying and discrimination

Note.   [1] Journal Citation Reports. [2] Journal Impact Factor. [3] SCImago Journal Rank.

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Table 3 (Continued)
Summary of selected articles.

Author (year)	Type of source and publication	Journal and journal quality index	Field	Participants	Description of the research methodology	Factors associated with mental state
Devís-Devís et al. (2018)	Academic article Research	*Physical Education and Sport Pedagogy* JIF: 5.830 JCI: 3.06	Experience and discrimination in sport (education)	Trans adults aged 23-62 years (5 trans women, 4 trans men) 9 in total	Qualitative. **Semi-structured interview**: about experiences in the heteronormative context of secondary school during physical education sessions (the questions are classified into four sections) 1- Difficulty in achieving desired gender 2- Preferences, dislikes and opportunities 3- Coping with transgression 4- Intimacy struggles	Violence and bullying
Doull et al. (2018)	Academic article Research (temporal study)	*Journal of Sport and Health Science* JIF: 7.179 JIC:1.73	Experience and discrimination in sport (students)	Data pooled at the population level for British Columbia, Canada (N = 99373). Sexual minority (LGB) and heterosexual youth. (48,410 men and 50,963 women)	Quantitative. Current portrait of sexual minorities' (LGB) sport participation, compared to heterosexuals. Pooled population-level data was used to examine trends and disparities between sexual minority and heterosexual youth. **logistic regression models** by ages were used to examine changes in participation over time and disparities in participation (1998-2013). The data presented is from four years (1998, 2003, 2008, 2013)	LGTBIphobic climate and frequency of participation in sport.
Greenspan et al. (2017)	Academic article Systematic review	*Journal of LGBT Issues in Counseling* SJR: 0.560	Experience and discrimination in sport (student athletes)	LGBTQ student athletes	Qualitative. **Systematic content analysis** of nine flagship journals published between 1975 and 2015 to be evaluated: 1- LGBTQ and mental health studies 2- School counselling 3- Counsellor education 4- School psychology 5- Counselling psychology 6- Sport psychology 7-Physical education	Mental health and discrimination
Greenspan et al. (2019a)	Academic article Research	*Journal of LGBT Youth* SJR: 0.583	Experience and discrimination in sport (education)	58 LGBTQ+ youth participants (respond to the survey) 13 participants (focus groups or interviews)	Qualitative and quantitative (mixed). **Survey and interview**: 1- What are the alliances and relationships of LGBTQ+ youth? 2- What are the experiences of LGBTQ+ youth and allies at school, with coaches or physical education teachers	Insecurity, discomfort and bullying in class

Note.   [1] Journal Citation Reports. [2] Journal Impact Factor. [3] SCImago Journal Rank.

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Table 3 (Continued)
Summary of selected articles.

Author (year)	Type of source and publication	Journal and journal quality index	Field	Participants	Description of the research methodology	Factors associated with mental state
Greenspan et al. (2019b)	Academic article Research (case study)	*Journal of Educational and Psychological Consultation* JIF: 1.711 JCI: 0.67	Prevention and inclusion (education)	LGBTQ youth	Qualitative. **Review**: examines the empirical underpinnings of the SAFE (School Athletics for Everyone) model for preventing discrimination against LGTBIQ youth, provides a successful example case, and disseminates relevant resources for practitioners	Stigma, discomfort and insecurity
Halbrook (2017)	Doctoral thesis Research		Perception and association of gender and sport (education)	10 LGTBI secondary school coaches (6 men and 6 women). Age from 31 to 68 years. Identify as heterosexual ($n = 9$) and gay ($n = 1$)	Qualitative. **Semi-structured interview**: The interviews were based on concrete examples and the experiences of the coaches while working with LGB athletes	Hostility and discrimination
Hargie et al. (2017)	Academic article Research	*International Review for the Sociology of Sport* JIF: 3.780 JCI: 1.40	Experience and discrimination in sport (adults)	10 self-identified trans-gender people, of whom 6 are women and 4 are men, aged between 25 and 62	Qualitative. **Interview**: 1- The changing room environment 2- The impact of sporting experiences at school 3- Fear in public spaces and the practice of sport and physical activity 4- Lack of perception of the health and wellbeing benefits of practising sport	Social stress, discomfort and anxiety
Krane (1996)	Academic article Narrative review	*Journal of Sport and Exercise Psychology* SJR: 0.908	Experience and discrimination in sport (professionals)	Lesbian athletes	Qualitative. **Analysis**: The context of lesbians in sport	Low self-esteem, low confidence, low satisfaction
Krane and Barber (2005)	Academic article Research	*Research Quarterly for Exercise and Sport* SJR: 0.793	Experience and discrimination in sport (professionals)	13 lesbian school coaches	Qualitative. **Semi-structured interview:** investigating the experiences of lesbian coaches at school level	Discomfort

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Table 3 (Continued)
Summary of selected articles.

Author (year)	Type of source and publication	Journal and journal quality index	Field	Participants	Description of the research methodology	Factors associated with mental state
Lee and Cunningham (2016)	Academic article Research	*Journal of Sport Psychology in Action* JCI: 0.60	Perception and association of gender and sport (adults)	Students 150 students (52 women, 98 men) enrolled at a large public university in southwestern United States	Quantitative. **Questionnaire**: The responses were focused on examining associations between sexual prejudice, sexism, gender, and identification with men's figure skating and American football. Participation was voluntary and the questionnaire took 10 minutes to complete. All responses were kept anonymous	LGTBIphobia, aggression, violence
Mattey et al. (2014)	Academic article Research (case study)	*Journal of Sport Psychology in Action* JCI: 0.60	Prevention and inclusion (adolescents)	Male and female volleyball players at state level. Under 15 / Under 17 / Under 19-23. Each age was separated by gender	Qualitative. **Anti-vilification programs in adolescent sport:** programs to combat violence in adolescent sports. Bullying prevention workshop. These were age-appropriate to take into account differences in cognitive and emotional development. The aim of the workshop was to raise awareness about LGTBI-phobic bullying. 1.5 hours	Bullying
Morris and Van Raalte (2016)	Academic article Narrative review	*Journal of Sport Psychology in Action* JCI: 0.60	Prevention and inclusion (adults)	Trans-gender and gender non-conforming people (TGNC)	Qualitative. **Analysis:** how to create sports spaces where trans-gender and gender non-conforming people can feel safe. Examining good practices related to TGNC persons	Anguish, mockery, violence and discrimination
Moscoso and Piedra (2019)	Academic article Literature review	*Revista Española de Sociología* JCI: 0.27	Experience and discrimination in sport (adults)	LGTBI population and sport	Qualitative. **Analysis:** the relationship between the LGTB population and sport. 1- History of sport and sexual minorities 2- Legislation, campaigns and policy initiatives on sexual diversity and sport 3- Overview of research	Discrimination and rejection

Note. [1] Journal Citation Reports. [2] Journal Impact Factor. [3] SCImago Journal Rank.

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Table 3 (Continued)
Summary of selected articles.

Author (year)	Type of source and publication	Journal and journal quality index	Field	Participants	Description of the research methodology	Factors associated with mental state
Pérez-Samaniego et al. (2019)	Academic article Review article (metasynthesis)	*Sport Management Review* JIF: 6.577 JCI: 1.43	Experience and discrimination in sport (adults)	Trans-gender people	Qualitative. **Metasynthesis:** 604 documents related to these issues were identified, from which 12 qualitative studies were selected. The key issues were divided into four cross-cutting themes: 1- Language 2- Installations and spaces 3- Trans-gender people's strategies on gender 4- Abjection	Feelings of exclusion
Petty and Trussel (2018)	Academic article Research (interpretative retrospective)	*Qualitative Research in Sport, Exercise and Health* JIF: 6.736 JCI: 1.44	Experience and discrimination in sport (education)	9 LGBT participants, 3 gay, 5 lesbian and 1 who identifies as trans-gender and gay. From 18 to 25 years old	Qualitative. **Intensive interview** about the experiences of identifying as LGBT in secondary school 1- Evocative research framework 2- Stories: as a form of knowledge and representation	Frustration, confusion and bullying
Phipps (2019)	Academic article Research	*International Review for the Sociology of Sport* JIF: 3.780 JCI: 1.40	Experience and discrimination in sport (education)	9 trans-gender students	Qualitative. Data from one student who identifies as trans* was extracted from a wider study of LGBT+ people in UK university sport	Bullying
Plymire and Forman (2001)	Academic article Research	*NWSA Journal*	Perception and association of gender and sport (professional sport)	NBA women's basketball fans, 44 surveyed	Qualitative. Examined how women's basketball fans approach the issue of lesbians in sport based on one post: "Is Cheryl Miller a lesbian?" 77 posts were collected between 21 April and 2 June 1997	Hiding sexual identity
Pronger (1999)	Academic Article Review	*Journal of Sport and Social Issues* SJR: 0.828	Experience and discrimination in sport (professionals)	Lesbian, gay and queer athletes	Qualitative. **Analysis:** of the theoretical framework on the sporting context that emerges from the interaction between elements of postmodern gay and queer theories	LGTBIphobia and stress

Note.   [1] Journal Citation Reports. [2] Journal Impact Factor. [3] SCImago Journal Rank.

Table 3 (Continued)
Summary of selected articles.

Author (year)	Type of source and publication	Journal and journal quality index	Field	Participants	Description of the research methodology	Factors associated with mental state
Sartore and Cunningham (2009)	Academic article Research	*Sex Roles* JIF: 4.154 JCI: 1.54	Perception and association of gender and sport (education)	Study 1: Current athletes in the United States of America (*N* = 229). Study 2: North American parents (*N* = 76).	Qualitative and quantitative (mixed). **Questionnaire, study 1:** questions about their participation in a sport coached by a gay man or lesbian, respectively. **Study 2** participants were asked whether they would allow their sons and daughters to be coached by a gay or lesbian coach. Going deeper into the topic, the open-ended question	Discrimination and stigma
Symons et al. (2017)	Academic article Research	*Annuals of Leisure Research* SJR: 0.520	Experience and discrimination in sport (adults)	Lesbian, gay, bisexual, trans-gender, over 18 years old. 294 completed questionnaires. Of the 294 participants, 52 % (*n* = 153) were men and 48 % (*n* = 141) were women	Qualitative and quantitative (mixed). To examine the impact on sexism and homophobic discrimination experienced by lesbian, gay and bisexual people in sporting settings. **Questionnaire with open-ended questions:** 1-Homophobia 2- Experiences of violence 3- Sexism 4-Other discrimination. It was asked under each category whether that category heading had been experienced and how often, and they were invited to give an example	Sadness, anger, anguish and shame. Negative engagement with sport
Turk (2018)	Doctoral thesis (case study)		Experience and discrimination in sport (students)	The research sample included 35 professional student-athlete participants who identify as sexual minorities in the NCAA (National Collegiate Athletic Association) Division I.	Qualitative. **Multiple data collection** demographic survey, interviews, focus groups, document review	LGTBIphobia languages of exclusion

Note.   [1] Journal Citation Reports. [2] Journal Impact Factor. [3] SCImago Journal Rank.

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Results

Initial database searches generated a total of 2,081 records, of which 26 studies met the inclusion criteria and were incorporated into the review. All studies were published between 1996 and 2019: 50% were published between 2018 and 2019; 23% between 2016 and 2017; 8% in 2014 and 2015, and the remaining 19% between 1996 and 2013. Therefore, an increasing trend can be observed since 2016, with the peak of publications in 2018, with seven publications. The vast majority of the articles included in the systematic review, 25, are written in English, and only one article in Spanish. In terms of method, 73% of the articles used a qualitative methodology, 15% used a quantitative methodology and 12% used a mixed methodology. With reference to the type of publication, 69% (18 studies) generated primary data with original research (case studies, temporal studies, interpretative and retrospective studies). Three articles analysed population-scale samples larger than 10,000 participants; three had samples of more than 200 participants; one article had a sample between 100 and 200; three had samples between 50 and 100; three had samples between 10 and 20; three of less than 10; and one article did not specify the number of study participants. Eight articles generated secondary data from review articles (narrative reviews and systematic reviews). Looking at the type of sample, 64% of the studies focus on sexual minorities as a group (16 articles), 20% on trans-gender people (five articles), 12% on lesbians (three articles), 4% on gays (one article) and the remaining 4% on queer people (one article).

The articles were classified into three fields, depending on the focus of the study: 1- experience and discrimination in sport, 2- prevention and inclusion 3- perceptions and associations of gender, identity and sexual orientation in sport.

Experience and discrimination in sport

Of the articles analysed, 16 belong to the category of experience and discrimination in sport. These investigate LGTBIphobic attitudes towards sexual and gender minority groups within the sporting environment and the mental health issues that this environment creates for them (Baiocco et al., 2018; Block, 2014; Devís-Devís et al., 2018; Doull et al., 2018; Greenspan et al., 2017; Hargie et al., 2017; Greenspan et al., 2019a; Krane, 1996; Krane and Barber, 2005; Moscoso and Piedra, 2019; Pérez-Samaniego et al., 2019; Petty and Trussell, 2018; Phipps, 2019; Pronger, 1999; Symons et al., 2017; Turk, 2018).

Half of the articles focused on adolescents. They described the sporting context as an LGTBI-phobic, unsafe environment, with instances of bullying, discrimination and intimidation. These circumstances increased the likelihood of mental health disturbances such as stress and depression (Block, 2014; Devís-Devís et al., 2018; Doull et al., 2018; Greenspan et al., 2017, Greenspan et al., 2019a; Petty and Trussell, 2018; Phipps, 2019; Turk, 2018). The characteristics of the sporting environment and instances of bullying based on the use of exclusive language led to a decrease in sporting participation from LGTBQ youth (Petty and Trussell, 2018; Turk, 2018). According to Turk, M. (2018), there is a lack of inclusion strategies on the part of coaches when it comes to making training sessions more dynamic.

The experiences of LGTBIQ+ people within the educational environment were described in five articles. These make explicit the difficulties, confusion and frustration of young people who admitted their sexuality or gender as people from a sexual and gender minority group (Petty and Tussel, 2018). In the school environment, young people also experience bullying, insecurity and discomfort in physical education classes. One article mentioned that LGTBIQ+ students preferred to engage in physical activity outside the school context (Greenspan et al., 2019a). There is also evidence of a lack of inclusive stimulation in physical education classes from teachers (Block, 2014; Devís-Devís et al., 2018). Within the educational setting, two studies examined trans-gender people. These described the problem of the binary context in physical education classes and reflected the importance of the role of physical education teachers. Finally, one of the common findings of the two studies was the barrier that locker rooms represented for trans students (Devís-Devís et al., 2018; Phipps, 2019).

On three occasions, the articles focused on professionals. In general, they agreed on two premises: LGTBIphobia as part of the sports culture, and that LGTBIQ professionals suffered bullying, abuse and stress in their work environment. Two of these articles referred to professional athletes (Krane, 1996; Pronger, 1999) and one referred to lesbian coaches (Krane and Barber, 2005).

Pronger (1999) concluded that LGTBIphobic sport environments and continually stressful situations could be the reason for eventually giving up sport. He also mentioned that more masculine competitive sports such as boxing, football, American football and hockey were more LGTBIphobic spaces. Krane's 1996 study focused on the mental health consequences of hostile and exclusionary environments for lesbian professional sportswomen, such as low self-esteem, low confidence, low perceived satisfaction and high stress levels. Only one study examined a sample of lesbian coaches and concluded

that each woman struggled to negotiate her lesbian identity in that environment, such that, in many cases, although the coaches were passionate about their profession, they were forced to behave in ways that conflicted with their personal values (Krane and Barber, 2005).

A total of five articles focused on sexual and gender minority group members over the age of 18. All studies agreed on the fact that sport was far from being universal, open and accessible to all people. They also described sport as dominated by heteronormativity, social control, power relations and discrimination against any sexual orientation that does not conform to the established norms of sport (Baiocco et al., 2018; Hargie et al., 2017; Moscoso and Piedra, 2019; Pérez-Samaniego et al., 2019; Symons et al., 2017). LGTBIphobia, discriminatory language and negative engagement with sport were also common findings. The articles described the sense of fear and insecurity and the bullying faced by LGBTI people in sport.

One of the articles focused on gay people and compared them to their heterosexual counterparts. It mentioned that gay people more frequently dropped out of sports because of fear of bullying. On the other hand, they also had stronger family pressure to participate in sports considered more masculine (Baiocco et al., 2018). Other studies, two in particular, looked at trans-gender people and concluded that they experienced stress, discomfort, anxiety and mental health problems, and also emphasised the issue of changing rooms as a barrier to playing sport (Hargie et al., 2017; Pérez-Samaniego et al., 2019).

Prevention and inclusion

As a result of the classification of the studies, four were included in the prevention and inclusion category. All had in common the analysis of the key points of the sporting context to generate safe and inclusive spaces for LGBTIQ people (DeFoor et al., 2018; Greenspan et al., 2019b; Mattey et al., 2014; Morris and Van Raalte, 2016).

Of these, three articles focused on the educational context with regards to adolescents (DeFoor et al., 2018; Greenspan et al., 2019b; Mattey et al., 2014) and one analysed the anti-vilification program, a programme to combat violence in sports for adolescents. It consisted of a workshop to prevent bullying in the sports context. The objectives of the programme were to raise student awareness of LGTBIphobic bullying through positive experiences in sport for all participants, to increase knowledge of the consequences of discrimination, and to help the athlete and coaching communities create safe and bullying-free environments (Mattey et al., 2014).

One of the articles described the importance of the role of sports medicine professionals in preventive and routine health care research (DeFoor et al., 2018). Another described the SAFE (School Athletics for Everyone) model by looking at environments for creating safe spaces in the sport context. This model enabled support for PE teachers to gain a broader understanding of the situations experienced by LGBTQ young people in sport settings, as well as offering mentoring support that enabled the development of practitioners in order to promote more positive and inclusive practices (Greenspan, et al., 2019b).

The last article in this category looked at trans-gender people. This article examined best practices related to the creation of safe spaces for these groups. Preventing discrimination involves raising awareness, creating safe spaces and highlighting the experiences of TGNC (*t*ransgender and gender-nonconforming) people (Morris and Van Raalte, 2016).

Perceptions of and associations with gender, identity and sexual orientation in sport

Finally, six articles were classified in the category of perceptions and associations of gender, identity and sexual orientation in sport. These examined the views of people in the sporting environment on sexual and gender minority groups (Anders and DeVita, 2019; Atteberry-Ash et al., 2018; Halbrook, 2017; Lee and Cunningham, 2016; Plymire and Forman, 2001; Sartore and Cunningham, 2009).

Four of the articles examined views on LGTBIQ+ people in education (Anders and DeVita, 2019; Atteberry-Ash et al., 2018; Halbrook, 2017; Sartore and Cunningham, 2009).

Two articles analysed coaches' perceptions of LGTBIQ+ athletes. In general, coaches considered sport to be devoid of sexuality, although they often described situations in which derogatory comments and jokes were made towards LGTBIQ+ athletes. In these situations, coaches downplayed the consequences, often justifying the comments as innocent banter (Anders and DeVita, 2019; Halbrook, 2017).

The perceptions of heterosexual students were analysed in an article examining views on support for guidelines protecting LGBT athletes in intercollegiate clubs. In a sample of approximately 40,000 students, 35% neither agreed nor disagreed with the guidelines, with a significant difference between male and female respondents in relation to mean LGBT support scores, with more support from female respondents (Atteberry-Ash et al., 2018).

One article examined athletes' and parents' perceptions of female coaches who identify as lesbian. It was concluded that athletes' perceptions were strongly associated with

unwillingness to participate in a team coached by a lesbian woman, and that parents' perceptions were significantly related to unwillingness to allow a lesbian woman to coach children (Sartore and Cunningham, 2009). And one article focused on defining adults' sexual biases by identifying their opinions in the analysis of two sports: men's figure skating and American football. A structural equation model was established showing that gender bias has a positive association with gender role identification in football and a negative association with gender role identification in men's figure skating (Lee and Cunningham, 2016).

Finally, the last article in this category examined the responses of a group of fans about the sexual identity of professional sportswomen; in this case, about basketball player Cheryl Miller. Responses analysed ranged from LGTBIphobic to supportive comments (Plymire and Forman, 2001).

Discussion

There are currently few published samples linking the LGTBIQA+ community, mental health illnesses and the sporting context, as only 26 articles met the inclusion criteria. However, there is a growing interest in this topic, as there has been an increasing trend in publications over the last three years.

Although social change has taken place in advanced societies, sport remains one of the most accentuated pillars of androcentric domination. It determines sport institutions structurally and symbolically (Moscoso and Piedra, 2019). Therefore, the sporting context results from the perceptions and negative associations of the population and, more importantly, of people who are in contact with sport, such as coaches, physical education teachers, athletes and professional sport enthusiasts. Often, this environment is unwilling to be inclusive, and LGTBIphobic situations are perpetuated as a result. The current sporting environment is far from being accessible and universal for all people (Baiocco et al., 2018). In general, there is a lack of awareness, knowledge and empathy among the population towards sexual and gender minority groups. It should be noted that women are more aware than men (Atteberry-Ash et al., 2018). More masculinised competitive sport environments are more exclusive and more LGTBIphobic situations occur, compared to other sports without these connotations (Pronger, 1999). These environments cause people belonging to a sexual and gender minority group to drop out of sport more frequently (Doull et al., 2018).

Most studies analyse LGTBIQA+ people's experiences of discrimination. The sports environment is described as a space of discrimination, bullying, intimidation, stigmatisation, with the use of exclusive language towards LGTBIQA+ people. Discrimination towards trans people can be more aggressive, sometimes involving episodes of violence (Devís-Devís et al., 2018). The described context causes mental health conditions for LGTBIQA+ people, such as anxiety, discomfort, stress, frustration, fear, low self-esteem, low levels of confidence, low satisfaction, sadness and depression. In order to change this trend, plans for prevention and changing attitudes towards people from a sexual and gender minority group in sporting contexts are needed. These programmes have to be based on education, awareness-raising and sensitisation of the environment. In the current literature, there are few studies on prevention programmes and reviews of good inclusive practices that provide tools for the environment and the people involved to neutralise the situation described above towards LGTBIphobic attitudes.

The review adopted broad search criteria to include all evidence in the areas studied, accepted research and reviews. Sample characteristics were not an inclusion criterion; however, a lack of research on LGTBIQA+, mental health and the sporting environment was identified.

If we focus on the object of the sample, we can perceive a lack of concrete and specific articles that analyse the mental health status of gay, lesbian, bisexual, trans, intersexal, asexual or queer people individually, not as a group, since each social group is affected by its own realities and characteristics. Of the 26 articles included in the review, none mention asexual people and none describe the situations of bisexual and intersex people individually. On the other hand, there is still no agreement on which acronyms are used to define sexual minorities, as each author uses different acronyms to describe and define the group (LGTBIQ+, LGTB, LGTBI, etc.). In this systematic review we have chosen to use the acronym LGTBIQA+ (lesbian, gay, trans, bisexual, intersex, queer and asexual, and the +, which is used to include other people who do not consider themselves cisgender or any of the other above designations), in order not to exclude any sexual and gender minority groups.

There is also a lack of articles analysing the reality of professional athletes, adolescents or people who practice federated or non-federated sport. Their situation in clubs, the perceptions of fans and the experiences of people in different sport contexts, in a gymnasium, non-professional leagues, etc., as each context has its own and often different reality.

It can be perceived that one of the limitations of the review has been the lack of specification of the study areas, as well as not limiting the age of the participants, the type of mental illness or the type of publication.

However, the aim of this approach is to understand and expose the situation of the LGTBIQA+ collective in the sporting context from a broad perspective.

Conclusions

In sport contexts, LGTBIphobic attitudes still exist, defined by situations of discrimination, bullying and stigmatisation. The results of the systematic review confirm the high prevalence of mental health problems such as stress, distress, sadness, upset, low self-esteem or depression in people belonging to a sexual and gender minority group. The analysis of the alteration of the mental health of LGTBIQA+ groups in sporting contexts is an emerging field of research interest. Although there are still few studies on this subject, most of them have been published in recent years, indicating an upward trend in publications in the areas studied. This review establishes the need for more research on the discriminatory experiences of sexual minorities in sport, with more specificity to the sporting context and type of sexual and gender identity. More studies on prevention programmes and reviews of inclusive good practice are also needed in order to challenge gender roles in sport settings, providing tools to both those affected and those around them. This information can help develop support and interventions aimed at increasing the well-being of people at risk of LGTBIphobic discrimination.

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PHYSICAL ACTIVITY AND HEALTH

School intervention with recreational motor activity for overweight children

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Abstract

The objective of this study was to verify the effect of a 12-week school intervention with recreational motor skills on parameters of body weight control, motor competence, and physical fitness in overweight students. The sample included 26 overweight children evaluated before and after a 12-week intervention period with recreational activities. Total body mass, height, abdominal circumference, skinfolds, physical fitness, and motor competence tests were collected. Results showed that recreational physical training significantly impacted on relative body fat reduction (pre = 28.3%; post = 26.1%, p = .03) and abdominal adiposity (pre = 71.0 cm; post = 68.1 cm, p = .04). A positive effect was observed on motor quotient, derived from better motor competence. The recreational physical training program was effective in reducing global and abdominal adiposity, as well as facilitating significant increases in motor competence, and cardiorespiratory and muscle physical fitness.

Keywords: childhood, obesity, physical education.

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Introduction

Child and youth obesity has increased worldwide, and in Brazil the prevalence is approximately 15% in children and teenagers between 2 and 19 years of age (Aiello et al., 2015). Obesity is known as a chronic disease of pediatric origin, and although some clinical outcomes manifest at early ages, others appear with higher intensity in adult individuals (Mosca et al., 2017; Nemet, 2018). During childhood, obesity has a negative impact on physical, social, and emotional health, and self-esteem. Overweight children have 17% to 30 % more chances of suffering bullying compared to normal weight children (Reulbach et al., 2013). At school, discrimination occurs in the form of verbal aggression, threats, and exclusion from groups (Bacchini et al., 2015).

In addition to these negative psychosocial implications, obesity leads to lower motor competence levels, which generates concomitant low levels of habitual physical activity in a cycle with negative feedback (Henrique et al., 2020; Sentalin et al., 2019). Thus, a systematic review study found evidence that excess body weight is associated with lower levels of motor competence, as well as a higher probability of giving up physical activity in childhood, and this inactive behavior can last during youth and adulthood (Cattuzzo et al., 2016). Valentini et al., 2020 highlighted that motor competence was a significant predictor of the level of habitual physical activity, where children with greater motor competence engaged more actively in Physical Education classes. On the other hand, heavier children perceived themselves as less competent in physical tasks and social interactions (Valentini et al., 2020; Stodden et al., 2008).

In contrast, training in fundamental motor skills for kindergarten students, instructed by a specialized professional, three times a week, improved motor proficiency and increased the intensity of habitual physical activity. As a consequence, sedentary behavior decreased together with a reduction in childhood obesity (Engel et al., 2018). In short, children with good motor coordination are more predisposed to engage in sports activities (Vandorpe et al., 2012). Confirming these findings, a sequential study of 27 years attested that the habitual physical activity level around the age of 6, significantly predicts physical activity in youth and adulthood (Telama et al., 2014), demonstrating that development of physical activity at pediatric ages can be stable and long lasting.

However, although the positive impact of motor practice in childhood on body weight control outcomes is recognized, it is known that the quality of available environmental stimuli for children is not enough to develop motor competence. Recently, researchers stated that physical education classes are commonly overcrowded, and the available space for physical activities is restricted both at school and in the community (Ré et al., 2018). Moreover, it was reported that children spend more time on sedentary behavior during the school term (Da Costa et al., 2017), and for this reason, it is important to introduce active breaks in all school disciplines, in order to reduce sedentary behavior time (Brusseau et al., 2018; Carlson et al., 2015). Thus, the need to intervene in school physical education classes is recognized, since students, especially obese students, need well-structured activities, intense enough to control body weight and other health-related variables (Bravo et al., 2020). Furthermore, improvement in children's physical fitness can have a remarkable influence on the quality of physical and mental health (Gu et al., 2016), as well as leading to a healthier lifestyle (Kari et al., 2016; Yuksel et al., 2020).

Accordingly, priority should be given to intervention strategies that increase physical activity and motor competence levels, mainly in kindergarten and elementary students (Ré et al., 2018). Recently, a Spanish study observed a low motor coefficient in 37.5% of preschoolers who participated exclusively in Physical Education classes. The authors considered that the short period of time in classes dedicated to motricity explains the low motor development observed among preschoolers (García-Marín & Fernández-López, 2020). Similarly, in Brazil, a cross-sectional study identified that children between 3 and 5 years of age who play sports in addition to school physical education classes present significant advantages in motor competence over non practicing children (Queiroz et al., 2014). Another Brazilian investigation observed that higher levels of locomotor skills in children of preschool age are associated with a lower risk of obesity, and that participation in sports that stimulate these skills are fundamental for individuals to engage in sports practice in early childhood (Henrique et al., 2020, 2016). In this scenario, it seems mandatory to incorporate additional extra-curricular practices into Physical Education classes to achieve adequate levels of motor competence, physical fitness, and weight control in childhood.

Based on these assumptions, the objective of the current study was to verify the effects of a school intervention with recreational motor skills during 12 weeks on parameters of body weight control, motor competence, and physical fitness in overweight students.
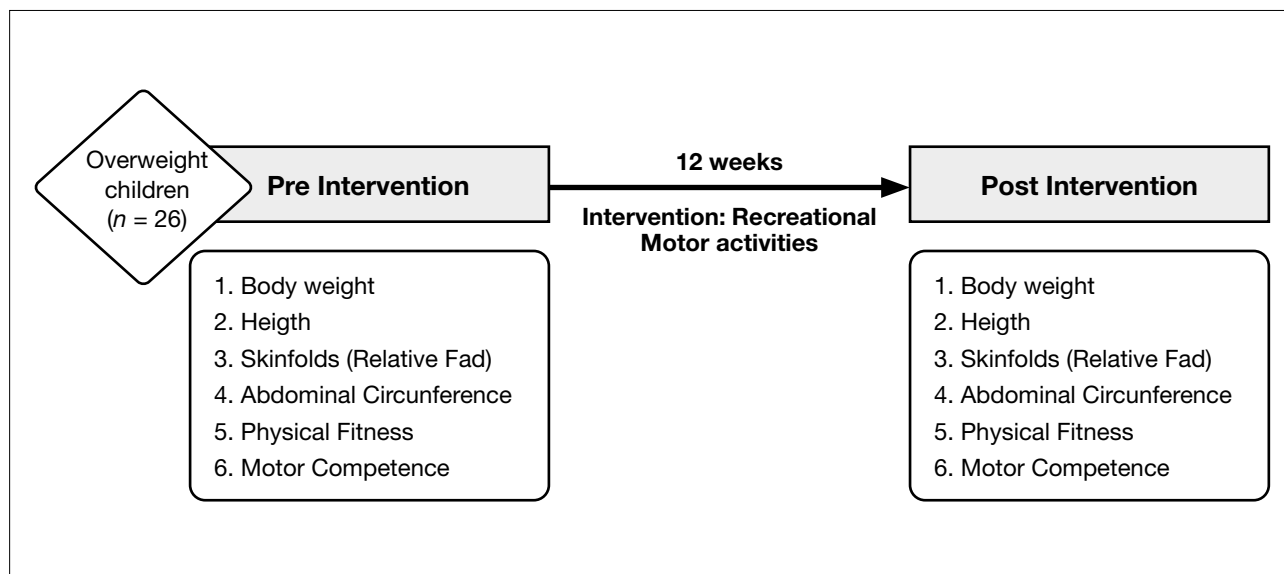
Figure 1
Flowchart 1. Study stages.

Methodology

Materials and methods

The study has a quasi-experimental design (pre/post test) with a sample selected by convenience due to the exploratory nature of the study. In total, 26 students of both sexes were included, aged between 6 and 9 years of age, 13 female and 13 male. The study received previous approval from the Human Research Ethics Committee (CAAE: 62267516.2.0000.5231).

The eligibility criterion for the included children was a Body Mass Index (BMI) above the 85th percentile, *i.e.* classified as overweight according to the Centers for Disease Control and Prevention criteria (Kuczmarski, 2002). Children undergoing nutritional monitoring or already included in a regular physical activity program, other than usual physical education classes, were excluded from the data analysis. The children's routine was not changed concerning eating habits, with only the addition of scheduled sessions of recreational motor activities. Furthermore, the predictive equations of Slaughter et al. (1988) were used for information on relative fat, to measure the triceps and subscapular skinfolds.

To ensure that all children included were in prepubertal or early puberty stages, skeletal maturation was assessed using hand and wrist radiography to obtain bone age, using the Greulich & Pyle method (1959). The exams were documented by a radiologist with extensive experience (blind evaluator).

Flowchart 1 highlights the stages of the study and the moments of assessment before and after 12 weeks of intervention with recreational motor activities.

All participants studied at the same full-time school and performed the intervention for 12 weeks during the extra-curricular period, totaling 36 sessions. The intervention took place three times a week on alternate days, lasting 60 minutes per session. Sessions were organized involving children in intermittent locomotor activities (running, jumping, moving); manipulation with balls (kicks, throws, tumbling), and stabilization (dynamic balance), all of which are recreational and collective, in order to ensure motivation for the practice (Errisuriz et al., 2018). The activities were carried out in a combined way so that the children performed activities of play, recreational games (catches, relay races, circuits), and dance. The internal training load was measured using a Polar® RS800, (Kempele, Finland) heart rate monitor. The intensity of the sessions reached a minimum of 70% of the maximum heart rate previously calculated by a specific predictive equation for pediatric groups (Mahon et al., 2010). The weekly frequency of intervention sessions was arranged using a roll call.

In order to verify the effect of the intervention on motor competence parameters, the Test of Gross Motor Development (TGMD2) was used, proposed by Ulrich (2000), and posteriorly validated for the Brazilian population (Valentini, 2012). The tests are composed of 12 motor skills, six for locomotion (running, canter, one-legged jump, obstacle hop, horizontal jump, and side run) and the other six for object control skills (hit, bounce, receive, kick, throw over the shoulder, and roll). In order to assess these skills, an experienced and trained evaluator demonstrated every movement and then the students tried once. During this trial attempt, the evaluator observed if the individual understood

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Table 1
Assessment of the methodological quality (PEDro scale) of the articles included.

Variables	Pre (*n* = 26) Median (Q1-Q3)		Post (*n* = 26) Median (Q1-Q3)		*p* value
Total body mass (kg)	35.1	(20.2 - 40.3)	35.5	(31.4 - 42.2)	.43
Height (cm)	1.30	(1.24 - 1.39)	1.31	(1.25 - 1.39)	.66
BMI (kg/m²)	19.9	(18.6 - 22.1)	20.4	(18.6 - 23.2)	.28
Relative fat (%)	28.3	(24.9 - 31.4)	26.1	(18.4 - 30.4)	.03*
Waist circumference (cm)	71.0	(67.5 - 77.9)	68.1	(64.2 - 77.1)	.04*

Note. *p* values based on *Wilcoxon's test* (*p < .05).

the move properly, and if not, a new demonstration was given. The students were filmed during two attempts at each skill which were then checked against the test scoring criteria, through completion of a specific registration form by three independent and experienced appraisers. The analysis of the motor competence videos was performed blindly, without contact and/or confirmation of the results by the evaluators.

For the outcome of physical fitness, the battery of motor tests of the Projeto Esporte Brasil (PROESP) was used (Gaya & Gaya, 2016). Cardiorespiratory fitness was investigated by the six-minute running test; the abdominal test was performed to detect strength and localized resistance; and the sit-and-reach test to check flexibility levels. All tests were performed on the court, following specific execution and classification criteria. Prior to the official evaluation day, the tests were performed with all children in order to familiarize them with the motor tests. The application occurred with one experienced evaluator and an assistant. The researchers who typed and processed the statistical analysis were blinded to the data collection, analysis of motor skills, and the intervention process.

Data normality was verified using the Kolmogorov-Smirnov test, confirming a non-parametric result, followed by the application of the Wilcoxon test to identify the existence of differences between the pre and post-intervention

moments. All procedures were performed using the SPSS 20.0 statistical package and a significance level of $p < .05$ was adopted.

Results

The results demonstrated that, before the intervention, all included children were in prepubertal or early puberty stages, with a mean bone age of 7.2 years, minimum 5.0 years and maximum 10 years. In addition, chronological age presented similar values, with a mean age of 7.7 years, minimum 5.7 years and maximum 10.1 years.
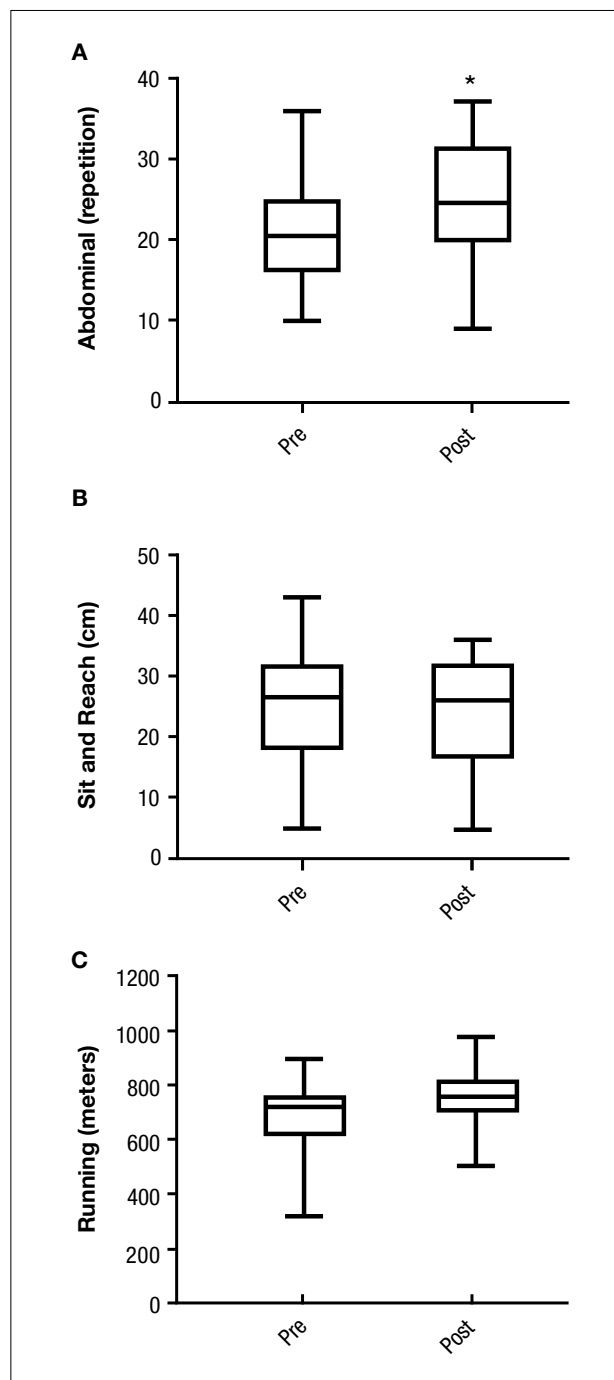
Regarding the impact of the intervention on body weight control, Table 1 shows median and interquartile range values at pre and post-intervention moments of anthropometric and growth variables. The results demonstrate a significant effect of intervention on reduction in total relative body fat and abdominal adiposity.

The results of the impact of the motor intervention show positive effects of 12 weeks of recreational motor activities in overweight children. There were significant improvements ($p < .05$) in locomotion and object control, reflecting significantly in the increase in motor quotient (median pre = 76.0 (63.2-79.7); post = 85.0 (76.0-91.0); $p = .001$) (Figure 2).
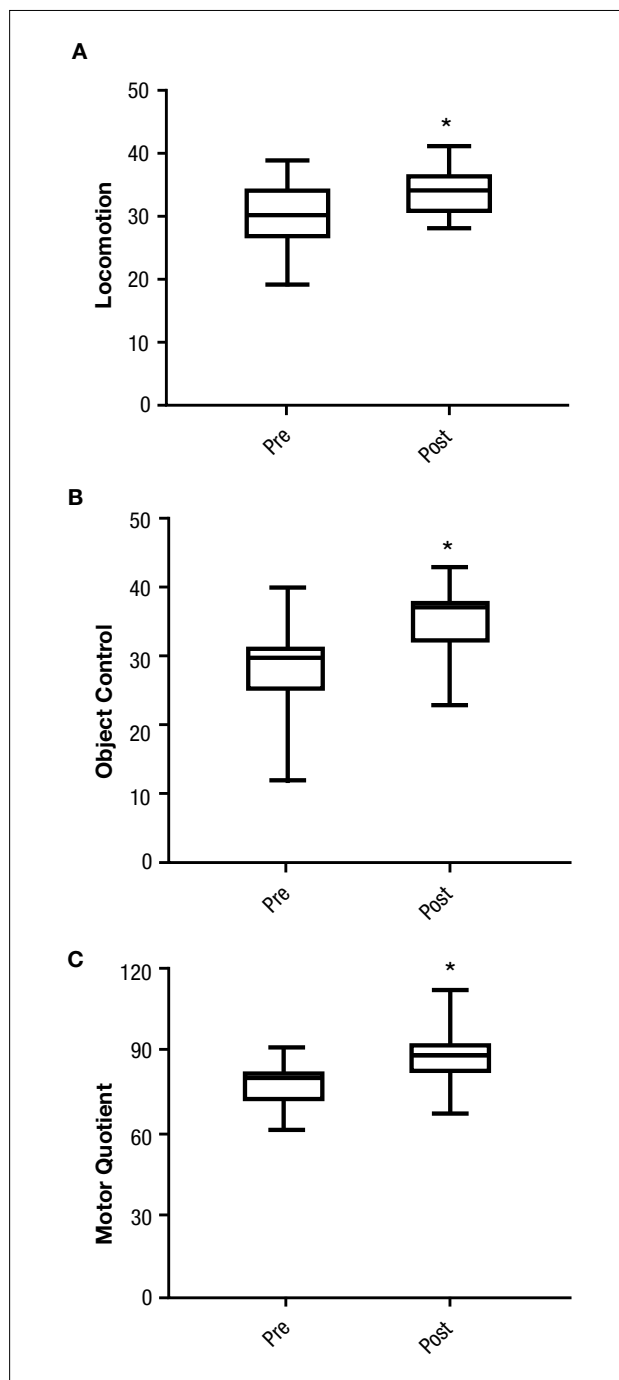
Figure 2
Box Plot (median and interquartile interval) of motor competence, presenting: A=Locomotion; B=Object Control; C=Motor Quotient.

Figure 3
Box Plot (median and interquartile interval) of physical fitness, presenting: A=Abdominal; B=Sit and Reach; C=Running.

The effects on physical fitness parameters are shown in Figure 3. There was a significant increase in abdominal localized muscle resistance (median pre = 20.5 repetitions [16-25]; post = 24.5 [19.7-31.5]; *p* = .043) and aerobic power assessed by the running test (median pre = 720 meters [609.7-762.2]; post = 757.5 [690.7-819]; *p* = .015). The sit-and-reach test performed to investigate flexibility did not demonstrate any significant difference after the intervention with recreational motor activities.

Discussion

The main results of the present study indicate a significant effect on reduction in relative body fat and abdominal adiposity, in addition to improvement in motor skills for locomotion and object control, which positively reflected on the motor quotient. Regarding the variables of physical fitness, there was a significant increase in localized abdominal muscle resistance and cardiorespiratory fitness.

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Similar results were observed by Delgado-Floody et al (2018), indicating that after 28 intervention weeks of High Intensity Interval Training (HIIT), with children between 6 and 11 years of age, there was a significant reduction in obesity through a reduction in the fat percentage and improvement in cardiorespiratory fitness. Reinforcing these findings, a recent meta-analysis with 15 longitudinal studies demonstrated that HIIT significantly improved cardiorespiratory fitness [VO_{2max} 1.117 (95% CI = 0.528 to 1.706, $p < .001$)] and reduced body weight [-0.295 (95% CI = 0.525 to -0.066, $p < .05$)] and body fat [-0.786 (95% CI = -1.452 to -0.120)] in children and teenagers of 6 to 18 years with obesity/overweight (Thivel et al., 2019). Additionally, an intervention of 12 weeks comparing HIIT, recreational soccer, and a control group indicated a positive effect on body composition, and an increase in lower limb strength, agility, and flexibility of overweight/obese males between 11 and 13 years of age (Cvetković et al., 2018).

Furthermore, through a cross-sectional study, researchers identified that obese children presented lower performance in flexibility than their normal weight peers (Bataweel & Ibrahim, 2020). Similarly, the present study did not observe an intervention effect on flexibility performance, probably due to the lack of a specific focus targeting this physical ability.

Regarding intervention models and strategies with a focus on overweight pediatric groups, the school environment is highlighted (Yuksel et al., 2020). Performing recreational and play activities with content that develops motor competence and keeps children active is indispensable. Thus, adherence to structured activities during school time or recess can be efficient for improving the health of children (Metos & Murtaugh, 2011). Furthermore, a cross-sectional study verified that organized physical activities are important contributors to motor skills and physical fitness in children, supporting the need for the provision of opportunities to practice daily organized physical activities, with school physical education programs representing an ideal environment for this objective (Hardy et al., 2014).

However, when investigating physical education classes and their possibilities, studies pointed out that the number of weekly classes and the intensity reached are not sufficient and are not efficient compared to extra activities to improve fitness parameters (Gallotta et al., 2017; Walker et al., 2018), remaining below the recommendations proposed by Childhood physical activity guidelines (Leitão et al., 2000). In this context, Thivel et al. (2011) proposed two extra classes per week of 60 minutes with playful activities to improve coordination, flexibility, strength, speed, and endurance, with positive results on obesity prevention through improvement in the aerobic and anaerobic fitness of children of 6 to 10 years (Thivel et al., 2011). Moreover, proposals to add 15 minute periods of functional and calisthenic movements

before class (Faigenbaum et al., 2015), participation in 2 hours per week in supervised group sports (Queiroz et al., 2014), additions of four vigorous physical activities of 60 minutes a week (Dallolio et al., 2016), and more active and intense standardized warm ups during physical education classes (Thomas et al., 2020) were shown to be efficient interventions with obese children.

In the present study, improvements in abdominal muscle fitness and cardiorespiratory condition were observed after a recreational intervention in addition to physical education classes with overweight children during 12 weeks, such as observed in another Brazilian study with sports activities twice a week, for children between 8 and 11 years old. Corroborating our findings, Ordóñez et al. (2019) in schools in Madrid, observed a significant improvement in cardiorespiratory capacity and motor coordination in children aged 11 to 12 years who participated in activities additional to Physical Education classes. Gonçalves et al. (2019) reported a reduction in relative fat and BMI and improvement in all physical fitness scores, including strength, endurance, and flexibility (Gonçalves et al., 2019). Previously, other studies demonstrated the efficiency of extracurricular interventions on weight and waist perimeter reductions in children, as well as improvements in physical fitness (Jansen et al., 2011). Furthermore, activities applied in the classroom significantly increased habitual physical activity levels of children (Reznik et al., 2015), and decreased BMI percentiles (Sharma et al., 2019).

Increasing physical fitness scores have special importance due to the reverse relation with overweight. Thus, a longitudinal study of 20 years following 1792 individuals between 7 and 15 years of age stated that low cardiorespiratory fitness is related to higher waist circumference (Schmidt et al., 2016). Similarly, Ruedl et al. (2018) observed that overweight and obese children have lower levels of physical fitness in comparison to normal weight children. Moreover, children presenting an improvement in health-related physical fitness and motor competence during childhood are less likely to develop overweight or obesity conditions (Rodrigues et al., 2016). Corroborating these assumptions, a prospective study reassessed the cardiorespiratory fitness of 647 individuals, stating that the lower the aerobic fitness, the higher the chances of becoming obese [OR 3.0 (95% CI 1.6-5.6)], and concerning elevated obesity, the likelihood of a reduction in physical fitness is higher between childhood and adulthood [OR 4.5 (95% CI 2.6-7.7)] (Dwyer et al., 2009). This highlights the importance of an active lifestyle that continues with child growth, providing continuity of physical activity during lifespan (Telama et al., 2014).

Regarding motor competence aspects, the scenario is very similar, since being overweight causes a negative impact on children's motor competence (Prskalo et al., 2015). Lima et al. (2019) reported an inverse relation of body

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fat and motor coordination, where children aged between 6 and 13 years with better motor coordination presented less body fat (Lima et al., 2019). Similarly, Augustjin et al. (2018) performed a multiprofessional intervention with obese children between 7 and 11 years of age. The results demonstrated that obese children presented lower levels of motor competence, manual dexterity, and static/dynamic balance, and presented more difficulty planning and controlling movements compared to healthy weight peers.. In another study, the association between motor competence and body composition was investigated in a group of 70 children of 6 to 10 years of age. The results showed that the motor proficiency of children was negatively associated with the amount of body fat. In addition, the study evidenced that normal weight children presented better motor competence in gross motor skills than overweight children (Marmeleira et al., 2017).

Notwithstanding, Zanella et al. (2016) discovered that a motor intervention program of 32 sessions significantly improved the motor domains of overweight and obese children between 6 and 8 years of age.

In the present study, despite the small sample size and the absence of a control group, the results demonstrated important responses to the 12-week recreational activities protocol in overweight children. Our findings indicate a significant reduction in relative and abdominal fat with improvement in the ability to move and control objects, reflecting positively on the general motor quotient. This particular outcome was shown by Barnett et al. (2009) to have great relevance, since proficiency in fundamental motor skills, mainly object control, subsequently predicted the time spent on moderate and vigorous physical activity in adolescence.

Lastly, from the authors' perspective, there are two strong findings. First, the efficiency of the intervention protocol in school to reduce central and total adiposity, and secondly, the positive effect on motor competence, and muscle and cardiorespiratory fitness levels, that together increase the chances of the incorporation of healthy habits and physical activities now and in future life.

Conclusions

The present study found a positive effect of a school intervention protocol with recreational motor activity on body weight control, motor competence, and cardiorespiratory and muscular physical fitness. The findings suggest that future investigations should confirm the impact of school interventions in the context of physical and motor activities on body weight control during childhood.

Author note

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Online training of sports coaches: bibliographic review

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Abstract

The current situation created by the global COVID-19 pandemic has put distance learning to the test at an unprecedented scale. The purpose of this study was to review the existing literature on online education of sports coaches carried out by official institutions (public bodies, federations, universities) and unofficial institutions (foundations, service companies and other educational organisations) through a systematic search of various databases. Data on study design, participants, variables, instruments, and results were extracted. After a selective search of the articles, the PRISMA checklist was used to select suitable articles for subsequent analysis and evaluation, which was carried out using the modified version of the Downs & Black checklist (1998). Fourteen descriptive and review studies were analysed for the coaches online learning preferences, its functionality and the applicable improvements. The analysis of the content of the articles allowed the identification of four main lines of research: description of the technological and computer tools available to the coaches, examination of the coaches' preferences, analysis of the use of resources by the coaches, and evaluation of the effectiveness of existing resources. The analysis of all of them allowed us to conclude that online learning is an extremely useful resource for the education of coaches, due to its advantages over traditional learning, despite some limitations such as the absence of physical interaction.

Keywords: COVID-19, education, sport, technologies, training.

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Introduction

The application of new technologies to the educational field has made it necessary to investigate the generation of new forms of knowledge transmission. Nowadays, almost all information is available on the Internet. Therefore, getting information is no longer a problem. The challenge is, as always, as shown by Mester and Wigger (2011), knowing how to compile, harmonise and adapt the information to the needs of the practical applications and also how to provide suitable feedback to the scientists.

The current situation created by the global COVID-19 pandemic has put distance learning to the test at an unprecedented scale (Callary et al., 2020). The success of this type of distance learning in training lies, according to García-Aretio (2009), in a series of aspects that characterise it: openness, ease of offering a wide range of courses; flexibility in timetables, space, rhythm, etc.; effectiveness; economy; ongoing education; motivation and initiative; privacy and individualisation; interactivity; active learning; collaborative learning; macro information; smart recovery; democratisation of education; democratisation of information; diversity and dynamism; immediacy; innovation; permanence; multi-format; multi-directionality; tele-ubiquity; freedom to edit; freedom to disseminate and interdisciplinarity. In addition, this training is, among other things, in line with new trends in physical activity and sports (Veiga et al., 2017), with the changes in the sports habits of groups such as sports science students (Rodicio-García et al., 2020) and with professional club training practices (Tarragó et al., 2019).

Online training and the sports coach

The training of sports coaches has received considerable attention from researchers, who have shown that the preferred sources for knowledge acquisition by coaches extend well beyond professional training courses and include a wide and varied range of informal and self-guided learning situations. There have been studies in this area of whether coaches actively select these modalities or if they only access them for convenience, due to the lack of availability, or the weakness, of other options (Reade et al., 2008).

The COVID-19 pandemic has put greater value on distance learning tools for coaches. Although many institutions and coaches have had these types of tools available, they were not being fully used (Callary et al., 2020). Beyond this exceptional situation, distance learning tools provide a resource that can increase the time spent on training courses, allowing the coach, who generally combines their education with their professional activity, to study and train whenever it suits them best (Over, 2008).

For in-person training, the relationship between teacher and student is direct and is fundamentally based on the direct transmission of knowledge in the classroom. But, in the digital classroom, teaching is based on studying using specially prepared materials (Gros et al., 2012).

In recent decades, a large number of sports organisations have begun to offer a wide variety of online resources for the teaching and training of coaches as well as other sports-related groups. For example, the most representative international sports organisation, the International Olympic Committee (IOC), on its Athlete 365 web platform, offers online training courses in various sporting fields, targeted at and accessible to athletes, coaches, referees and all interested parties (COI, 2021).

The sports federations for the various disciplines now include innumerable online training resources in their development programmes. So, by way of example, the International Tennis Federation (ITF) has developed an online platform, the ITF Academy, in which it offers a wide variety of courses, covering both general and tennis specific topics. The courses are presented using text, images, video, audio and also animations, to ensure that the content is both interesting and attractive. In addition to the courses, the platform offers the official ITF library, in which can be found exercise videos, lectures, articles and research papers to meet all of a coach's information needs (ITF, 2021). This is an example of a platform on which coaches can easily access up-to-date resources prepared by proven coaches, allowing quality ongoing education throughout their careers, if they want it (Sackey-Addo and Pérez, 2016). As Over (2008) argues, any strategy that makes training more attractive, functional, and practical for coaches will ultimately have a positive effect on the quality of the work of coaches around the world. Therefore, in order to create and offer new digital content and material, it is crucial to understand the needs of those involved.

In addition to the International Olympic Committee and the international federations of the various sports, most national federations and other academic, state and sporting institutions are also offering, as part of their coach education programmes, the option of accessing online education through training courses and educational resources on their web platforms. Thus, UEFA (Union of European Football Associations) offers, as part of its training programme, UEFA Academy, a combination of

its in-person courses with some online modules and some fully online courses (UEFA, 2021).

It is also important to highlight the training offering from foundations, service companies and other educational corporations that develop training resources. Many of them are endorsed by recognised entities or by federations and universities, providing greater recognition of their resources. This is the case for the High Performance platform, which offers in-person and online courses that are taught under the Europe Active standards, formerly known as EHFA (European Health and Fitness Association) and that are endorsed by the University of Alicante. They are aimed, among others, at athletes and coaches in various sports and include training in physical fitness, sports performance, nutrition, etc. (Alto Rendimiento, 2021).

Given the importance of online training in the education of coaches, the purpose of this systematic review was to identify and analyse studies into the use by sports coaches of online resources for their training. To this end, a search was carried out of the Web of Science databases (WOS, CCC, DIIDW, KJD, MEDLINE, RSCI, SCIELO), SCOPUS, PubMed and EBSCO (SportDiscus, ERIC, Education Research, APA PsycInfo, MedLine, CINAHL) .

Methodology

Sample
First we identified the terms for the bibliographic search, the descriptors and the synonyms in English and Spanish related to our work topic: ("coaches" OR "coach education"), "online ", "sport" and ("learning" OR "education"). With these terms the equation suited to each information source consulted was created, according to the characteristics and options each of them offered: (1) ("coaches" OR "coach education") AND "online" AND "sport" AND ("learning" OR "education"), and (2) ("entrenadores" OR "formación de entrenadores") AND "en línea" AND "deporte" AND ("aprendizaje" OR "formación").

The bibliographic search was carried out over several documentary sources in both English and Spanish. First, a search was performed on the Web of Science online bibliographic reference database of scientific information. This is an online scientific information service, a multidisciplinary database of bibliographic references that allows access to the electronic collections of Thomson Reuters, enabling a global search of all its databases. This enabled access to a large number of articles, giving an overall view of the status of the study. The search was then continued of the following databases: Scopus, PubMed, and EBSCO. Finally, the process was completed by carrying out an additional search to complement the equation used, reviewing the article references and using other sources.

Process
After entering the search equation into the various databases, the following results were obtained * (since 2005/no books, conferences, etc.): WOS, 65 results; Scopus, 41 results; PubMed, 24 results; EBSCO, 97 results, giving a total of 224 articles, among which a total of 104 repeated references were detected, giving a final result of 120 articles obtained. In turn, an additional manual search was performed by reviewing the bibliography of each of these articles. The Cited References Search tool from the Web of Science database was also used to identify studies that had cited the articles identified in the main search. These references, added to those previously mentioned, resulted in a total of 138 articles.

The title of each of these articles was reviewed to determine their potential relevance to our review. If the title of the article seemed appropriate, the abstract was read to confirm whether it was related to our study. Research was excluded according to any of the following criteria: articles not written in Spanish or English, articles that did not show the full text in their digital version and articles with references to the use of technology in training, but not in the education of the coaches. After this filtering, a total of 16 articles were included for final review. To confirm their validity for the study, the articles that met the inclusion criteria were read in their entirety: articles in English or Spanish, published since 2005 and related to the use of online education or the use of new technologies for education. Of the 16 articles reviewed, two more were excluded, because the study sample was made up of students rather than coaches and because they were limited to the use of one specific resource such as online blogs. Finally, 14 articles were selected that met the inclusion criteria established for performing the study (Figure 1).
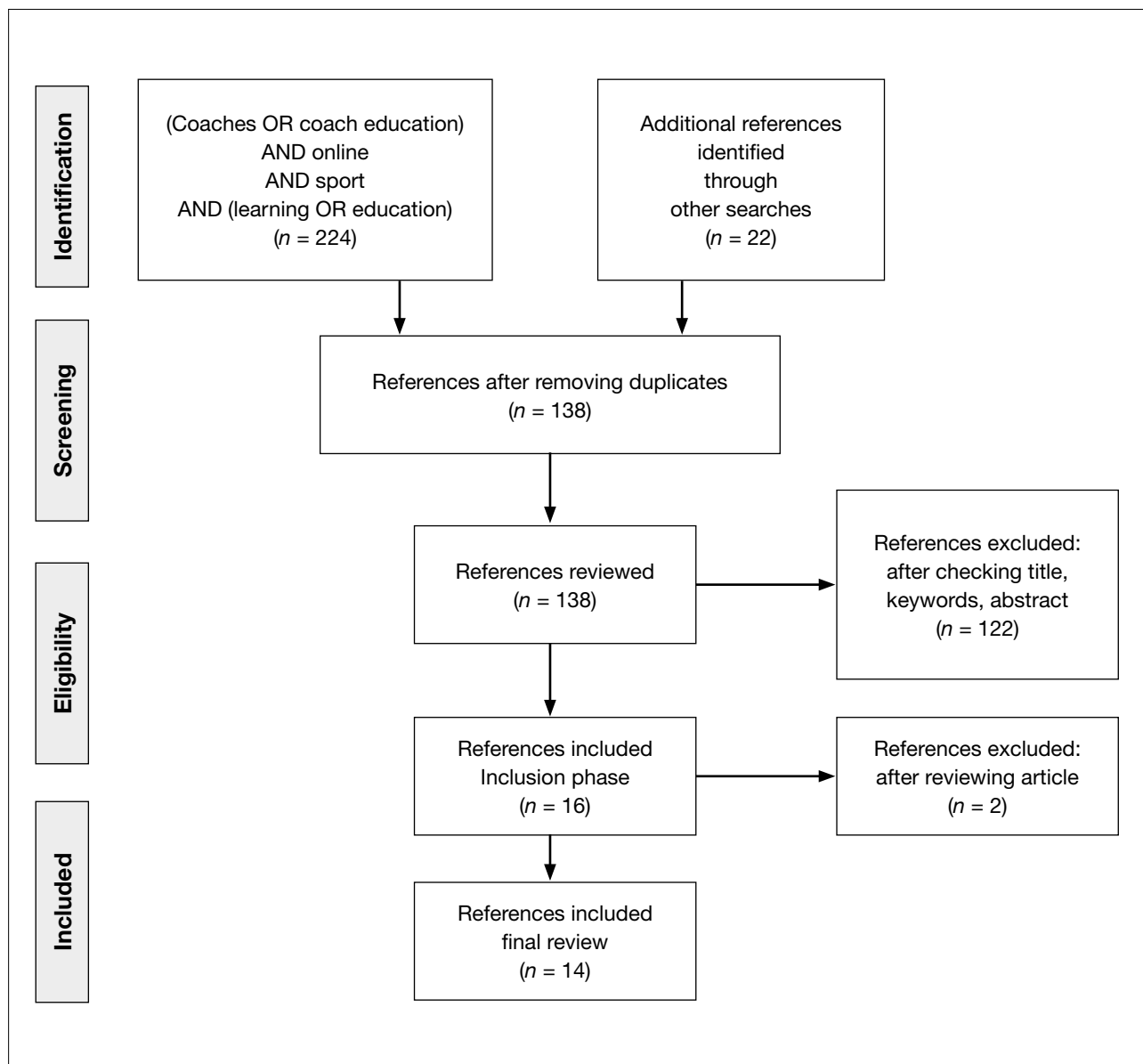
Figure 1
Flow chart based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Literature analysis

After using the PRISMA checklist in order to select suitable articles for the subsequent analysis, the quality of the research methodology used in the articles included in the final selection was assessed using the modified version of the Downs & Black (1998) checklist. This method was applied to assess each article in the following categories: study purpose, background of the literature, study design, sample, statistical significance, data analysis methods, results, conclusions and implications for future research (see footnote to Table 1). These questions were assigned a rating of + (meets criteria), - (does not meet criteria), or NR (not recorded) for each article. An NR score indicates that no information was available on the reliability or validity of the instruments used in this systematic review. The scores obtained for the ten questions were added for each article, counting the NR score as 0. Table 1 shows the methodological quality of the reviewed studies. A total score of less than 5 indicates low quality, a total score between 5 and 7 points indicates good quality, and a total score of 8 points or more indicates high quality (Van der Fels et al., 2015).

Table 1
Scores for a modified version of the checklist (Downs and Black, 1998).

Author (Year)	1	2	3	4	5	6	7	8	9	10	Total
					Question number						
Cushion and Townsend (2018)	+	+	+	+	+	+	+	+	+	+	10
Driska (2018)	+	+	+	+	-	+	+	+	+	+	9
Koh et al. (2017)	+	+	+	+	+	+	+	+	+	+	10
Stoszkowski and Collins (2015)	+	+	+	-	+	+	+	+	+	+	9
Kubayi et al. (2016)	+	+	+	-	+	+	+	+	+	+	9
Sackey-Addo and Pérez (2016)	+	+	NR	NR	+	NR	+	+	+	NR	6
Pope et al. (2015)	+	+	+	-	+	+	+	+	+	-	8
Augustýn and Jůva (2014)	+	+	+	-	+	+	+	+	+	-	8
Callary et al. (2011)	+	+	+	+	+	+	+	+	+	+	10
Mester and Wigger (2011)	+	-	NR	NR	+	NR	+	+	+	NR	5
Sanz (2011)	+	+	NR	NR	+	NR	+	+	+	NR	6
Cushion et al. (2010)	+	+	NR	NR	+	+	+	+	+	+	8
Reade (2008)	+	+	+	+	+	+	+	+	+	+	10
Over (2008)	+	-	NR	NR	+	NR	NR	+	+	+	5

Note. NR = not recorded; + = meets the criteria; - = does not meet the criteria; (1) Was the objective of the study clearly stated? (2) Was relevant prior literature reviewed? (3) Was the sample described in detail? (4) Was the sample size justified? (5) Was the design appropriate for the question investigated? (6) Were the results reported with their statistical significance? (7) Were the analysis methods appropriate for the investigation design? (8) Were the conclusions appropriate given the study findings? (9) Are there implications for future research given the results of the study? (10) Did the authors acknowledge and describe the limitations of the study?

Results and discussion

Table 2 shows the first author of the study and the year, the objective of the study, the method used and a summary of the results obtained for the 14 articles included in the review. The analysis of the article content allowed us to identify four lines of research. Table 3 shows these lines and the articles that cover them. This classification gives us a global vision of the research that analysed the use of online resources by coaches. Although some articles may cover several topics, they have been included in the one that is considered most representative of their objective.

Describing the technological and computer tools that coaches have available for their education and training is the first line of research that was found from the analysis of the articles. It focuses on a description of the technological tools and resources that coaches have at their disposal for their online education. Cushion et al. (2010) highlighted that coaches learn in various ways and from various informal and formal sources. They suggest that informal learning through coaching experience and interaction with other coaches remains the dominant mode of learning compared to online learning.

Table 2

Summary of the most relevant characteristics of each of the studies included in this review.

Study	Objective	Method and sample	Results
Cushion and Townsend (2018)	To consider evidence of technology-enhanced learning in the education of coaches	Review study: systematic review	Despite the use of technology in training, teaching and learning, the evidence for its efficacy is weak, and its use requires further research
Driska (2018)	Assess the effectiveness of online education programmes	Descriptive study. Semi-structured interviews. $N = 21$	The assessment showed positive perceptions of the course and demonstrated that it can help expand learning opportunities and professional development
Koh et al. (2017)	To investigate the perceived benefits of using internet coaching resources, the types of internet resources sought by youth soccer coaches, and also how the resources are used to improve their coaching knowledge	Descriptive study. Personal interviews. $N = 10$	The Internet was seen as a source for learning, due to its easy accessibility, time saving, low cost and the availability of new ideas. Google, Facebook, YouTube and Twitter were the most common platforms used to find learning resources, but checking the credibility of these learning resources is the biggest challenge that coaches face
Stoszkowski and Collins (2015)	Explore coaches' perceptions of their actual and preferred methods of acquiring new training knowledge	Descriptive study. Online survey. $N = 320$	Coaches preferred, and mostly acquired, coaching knowledge through informal learning activities
Kubayi et al. (2016)	To examine the coaches' preferences for their ongoing education	Descriptive study. Surveys during attendance at training courses, workshops and seminars. $N = 224$	Coaches wanted to learn more about motivational techniques and were more likely to continue their education as coaches if they wanted to train at a high level if the topics were relevant, and if the courses were available online
Sackey-Addo and Pérez (2016)	Analysing the evolution of online learning for sports coaches: a tennis perspective	Review study: systematic review	The use of good quality resources and materials obtained through online learning platforms produced benefits, not only for tennis coaches, but also for the tutors
Pope et al. (2015)	To examine the content of the information that coaches get from online sports psychology resources and its use	Descriptive study. Online survey. $N = 253$	Coaches currently get information from online sports psychology resources "a few times a year," but would get it "once a month" if more accessible and credible resources were available

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Table 2 (Continuation)
Summary of the most relevant characteristics of each of the studies included in this review.

Study	Objective	Method and sample	Results
Augustýn and Jůva (2014)	To analyse the use of ICT in informal education and informal learning for handball coaches	Descriptive study. Questionnaires. *N* = 186	The most frequently used sources are the materials on the Federation's websites and the least used are paid-for sources, E-learning, webinars and video conferencing. 91% of coaches regularly use methodological materials on the Federation's website. A computer is the most frequently used ICT medium for coaches for their education, but not especially so during training or matches. Progressively greater use of mobile phones is also to be expected, due to their many functions, such as a camera and the ability to work with video, but there is apparently a lack of suitable applications to allow their wider use
Callary et al. (2011)	To use information from a survey to continue developing their coach education programme	Descriptive study. Online survey. *N* = 765. It is estimated 45% of active coaches	The authors considered ways that sports organisations could use the survey information to further develop their coach education programme from an ongoing learning perspective
Mester and Wigger (2011)	To explore online resources for the education of coaches	Review study: systematic review	Accessing information is no longer a problem. The challenge is, in any case, knowing how to compile, harmonise and adapt the information to the needs of the practical application and also to provide feedback to the scientists
Sanz (2011)	To describe some of the most frequently used tools for the ongoing education of tennis coaches	Review study: systematic review	New technologies for education are already available and the internet has had a great impact on access to information and education
Cushion et al. (2010)	Provide an overview and analysis of existing research on coach learning	Review study: systematic review	Coaches learn in a variety of ways and from various sources: informal, non-formal, and formal. Informal learning through coaching experience and interaction with other coaches remains the dominant mode of learning
Reade et al. (2008)	To discover how high-performance coaches access the knowledge of sports scientists	Descriptive study. Questionnaire. *N* = 205	There are differences between what coaches are looking for and the research that is being carried out, especially in the area of tactics and strategy. Coaches are more likely to consult other coaches or to attend coaching conferences for new information
Over (2008)	To describe current advances available to coaches and players through information technology and computers	Review study: systematic review	The accessibility of these resources and the progress of technology allow training in areas and lifestyles for people who had not previously been exposed to this quality of information, at relatively low cost for both the coach and the federations

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Table 3
Lines of research and studies which they consist.

Line of research	Studies
To describe the technological and computer tools available to coaches for their education and skill acquisition	Over (2008), Cushion et al. (2010), Sanz (2011), Sackey-Addo and Pérez (2016)
To examine coaches' preferences for their education	Reade et al. (2008), Callary et al. (2011) Pope et al. (2015), Kubayi et al. (2016), Stoszkowski and Collins (2015)
To analyse the use of online resources by coaches for their education	Mester and Wigger (2011), Augustýn and Jůva (2014)
To assess the effectiveness of online education resources and programmes for the education of coaches	Koh et al. (2017), Driska (2018), Cushion and Townsend (2018)

For his part Sanz (2011) stated that new technologies intended for education are here now and that the internet has had a great impact on access to information and training. Along the same lines, Sackey-Addo and Pérez (2016) highlighted the importance of using resources and content of proven quality in online education platforms for coaches.

In view of the studies analysed in this line of research, one proposal for improvement would focus on the need to delve into the typology of the various tools and resources used by coaches and, especially, go deeper into their quality.

Examine the coaches' preferences for their education. This second line of research focuses on examining the coaches' preferred education techniques. Several descriptive studies have been done using surveys to discover their opinion on the information they can obtain and their usage preferences. The results of Pope et al. (2015) showed that they acquire information from online sports psychology resources "a few times a year", but would obtain it more frequently if more accessible and better quality resources were available.

From the study by Callary et al. (2011) it is appropriate to highlight the importance of the online surveys given to the users/coaches of the education platforms. After surveying 765 coaches, these authors argued that sports organisations could use the survey information to continue developing coach education programmes for ongoing education. In contrast, the article by Stoszkowski and Collins (2015) concluded that coaches preferred, and mostly acquired, knowledge about coaching from informal learning activities, especially when these allowed social interaction. For their part, Kubayi et al. (2016) in their study concluded that sports coaches were more likely to continue their education as coaches if they wanted to train at a high level, if the topics were relevant and if the courses were available online.

A proposal for improvement for this second line of research would be related to a study of the level of accessibility of the online resources, of their relevance to coaches and, specifically, to the importance of ongoing education or ongoing professional development.

The third group of studies is made up of those that analyse the use of online resources by coaches for their education. Some results showed that the coaches habitually used ICT resources both in their personal life and in their education. Two-way communication and e-learning courses on the Internet, forums, webinars, etc., were used significantly less.

Augustýn and Jůva's (2014) study concluded that coaches did not use ICTs too often during training or a match, hoping that with the development of new applications they will begin to use them more often. For their part, Mester and Wigger (2011) concluded their study stating that accessing information is no longer a problem. In their opinion, the challenge is, in any case, knowing how to compile, harmonise and adapt the information to the needs of the practical application and also to provide feedback to the scientists.

For this third line of research, a proposal for improvement would focus on the analysis of the use of new applications that provide coaches with access to online resources in various personal and professional circumstances, specifically those that allow their use during training sessions and matches.

The fourth and final line of research focuses on evaluating the effectiveness of online education resources and programmes for educating coaches. After this systematic review, we can verify that most of the articles highlight online education of coaches as a resource they all appreciate and that, in turn, improves and facilitates the learning of new skills (Koh et al., 2017) . Cushion

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and Townsend (2018) stated that, despite the increase in the use of technology in teaching and learning, the evidence for its efficacy is weak, so further investigation is required. On the other hand, Driska (2018) highlighted how the coaches learned and implemented changes in their training thanks to their learning from the online education they took part in. The assessment showed positive perceptions of online courses and also showed that using them could help expand learning and professional development opportunities for its members. The coaches saw the Internet as a source of learning, due to its easy accessibility, time saving, low cost and the availability of new ideas. Google, Facebook, YouTube, and Twitter are common platforms for locating learning resources, but assessing the credibility of those resources is the biggest challenge facing coaches (Koh et al., 2017).

Proposals for improvement related to this line of research could be aimed at analysing the effectiveness of online learning and, specifically, its practical application in the context of the daily work of coaches in training and competition situations.

Conclusions

Most of the articles selected agree in pointing out that online learning is a very useful resource for the education of coaches, although some limitations were identified. In most of the research, the online learning the coaches took part in stands out in a positive way, except for one of them, for which it was determined that social interaction helps more in the acquisition of knowledge. Therefore, it is possible to conclude that research agrees that online learning can be a very useful tool for educating coaches. Therefore, due to its use, importance, application and acceptance, we consider that it is a field of study that requires not only further development but also greater research effort.

As for the future prospects of online learning, the results of our study confirm that this modality is increasingly being consolidated into all educational and work areas in general and among sports coaches in particular. So it is of vital importance to carry out more research to enable the in depth discovery of the characteristics of the contents and the available resources required for this trend to be truly useful to the user. For this reason, we consider that it is necessary to open future lines of research that are aimed at studying in greater depth the specific characteristics that define this field. Thus, it will be possible to contribute to the discovery and analysis of suitable types of resources for coaches in terms of new technologies and online education and learning systems.

For the practical applications, we consider that it is essential to identify and study both general and specific content that coaches need to access to improve their education and which of them they prefer, if they opt more for material resources that help them to follow self-administered education or are more in favour of a more formal strategy through targeted courses. It is also important to know the type of material that is of most interest to coaches: short videos, lectures, explanatory dossiers, case studies, question and answer sessions, exercises, etc. Finally, the most suitable structure and delivery options in which to offer the resources should be investigated so that coaches or other users can access them using online platforms, social networks, mobile applications or other systems yet to be discovered.

Authors' note

All the authors declare that: this is an original work; it has not been previously published in whole or in part; it is not in the process of evaluation by any other publication; all the authors are responsible for the final version of this article, to whose preparation they have contributed; the fact of it being accepted for publication implies that all copyright is transferred to the National Institute of Physical Education of Catalonia (INEFC), which assumes exclusively all rights to edit, publish or reproduce it in any format, and without whose permission none of the materials it consist of may be reproduced, in whole or in part.

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EDUCACIÓN FÍSICA Y DEPORTES

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Isoinertial Strength Training in Older Adults: A Systematic Review

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Abstract

The maintenance of skeletal muscle and its ability to generate greater nerve stimuli are favoured by the use of isoinertial equipment, since these allow greater tendon and neuromuscular performance together with better metabolic dynamics in the face of loss of lean mass (sarcopenia) and muscle strength (dynapenia) in older adults, due to multifactorial effects such as: increase in catabolic cytokines that cause protein degradation, atrophy, hormonal disorders, increase or decrease in fat mass. The purpose of this study was to establish the neuromuscular effects of isoinertial strength training by older adults. A review of the scientific literature on the effects of isoinertial training on neuromuscular performance in older adults is presented through a database search (PubMed/MEDLINE, ScienceDirect, ProQuest). The isoinertial training mechanism generates positive changes in motor unit recruitment, strength and power levels, maintaining neuromuscular and tendon function in older adults.

Keywords: aging, eccentric training, isoinertial exercise, older adult, sarcopenia.

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Introduction

Changes have been identified at the hormonal, neuronal and muscular levels as a result of the changes linked to age and functional performance in the elderly, (Algilani et al., 2014; Strasser et al., 2018; Ticinesi et al., 2019; Vandervoort, 2002). These changes produce a decrease in muscle strength and power (Latham et al., 2009; Vandervoort, 2002), and are associated with variation in motor neurons, the capacity for protein synthesis, and changes in cartilage, joints and tendons (Fernández-Argüelles et al., 2015). On the other hand, impacts on the neurological system have been seen including changes in the size and number of motor units, dendritic ramifications, and weakness in motor nerve conduction (Foldvari et al., 2000). Thus, strength is affected around the third decade of life and continues to decline progressively (Granacher et al., 2008), depending on multiple factors such as age, sex, and physical activity, among others (Russ et al., 2012; Vandervoort, 2002).

According to scientific data, a significant decrease in strength of 1 to 1.5% per year between the ages of 50 and 70 has been established (Vandervoort, 2002), as well as changes and degeneration of the spine that can produce stability, posture, function and dynamism problems (Borde et al., 2015; Mitchell et al., 2012; Russ et al., 2012). Therefore, the motor performance of the elderly depends on developing resistance through training programmes, which aim to maintain the characteristics by keeping up muscular strength through eccentric dynamics, as a fundamental basis of the adaptive physical condition that aims to maintain the number and diameter of myofibrils, especially those of type II, as a result of the production of power (Maroto-Izquierdo et al., 2017; Wonders, 2019) as an essential factor in human functional capacity.

For this reason, muscular mechanical performance through negative (eccentric) contractions in tension training justifies the use of isoinertial action equipment. This equipment aims to increase strength, improve musculotendinous elongation (Guilhem et al., 2010; Hedayatpour and Falla, 2015; Schoenfeld et al., 2017) and increase power production as well as metabolic efficiency, together with a lower cardiovascular requirement, generating strategies that combat sarcopenia (Hedayatpour and Falla, 2015), due to loss of muscle mass and strength, decreased bone mass, fragility, depression, sleep disturbances and the incidence of falls (Granacher et al., 2013; Petré et al., 2018; Sañudo et al., 2019).

As described by recent studies, the ability to apply eccentric resistance throughout the full range of motion generates satisfactory strength gains compared to traditional training (Bogdanis et al., 2018; Sánchez-Moreno et al., 2017; Yamada et al. al., 2012), which would lead to performing work with a lower ideal energy expenditure in clinical and sports rehabilitation processes (Aboodarda et al., 2016;

Guilhem et al., 2010; Pareja-Blanco et al., 2014) . Speaking more specifically of the older adult population, there has been research designed to study the best way to achieve satisfactory results for strength gain.

Likewise, it has been suggested that isoinertial exercises can lead to improvements in terms of hypertrophy and functional adaptation, which are related to contractile capacity and muscle elongation in the elderly population (Maroto-Izquierdo et al., 2017). Similarly, studies have revealed that isoinertial training can improve aspects of muscle function, such as: strength, power, neuromuscular activation and structural improvement (Bruseghini et al., 2019).

Therefore, the purpose of this review becomes important when establishing the neuromuscular effects of isoinertial strength training in older adults.

Methodology

Using a descriptive cross-sectional study of articles published using a narrative review, a search was carried out between March and September 2020 in databases such as PubMed/MEDLINE, ScienceDirect and ProQuest. Published studies that were not in Spanish or English were excluded.

Search strategy

A search for publications was performed using the MeSH tool, using keywords such as aging, flywheel training, sarcopenia, strength training, eccentric overload, older adults. Subsequently, a new search was carried out using Boolean (logical) operators such as: "isoinertial" OR "isoinertial training" OR "Training eccentric overload" AND "Flywheel training*", "Older adults*" OR "senior training*" AND "Strength training", "muscle *" AND "neuromuscular function", "skeletal muscle" AND "older adults*" OR "training*", "muscle coactivation" AND "seniors*" OR "older adults*", "sarcopenia" AND "aging*" OR "Older adults*"

Selection process

300 articles were found, from which duplicate studies and those that did not meet the study's objectives (exclusion criteria) were eliminated, giving a final total of 70 publications.

Of the remaining articles that included resistance exercises, those ($n = 20$) which performed training that did not include inertial overloads were eliminated. Finally, of the 50 articles that met the inclusion criteria proposed by the researchers, 18 were used for this review (Figure 1).
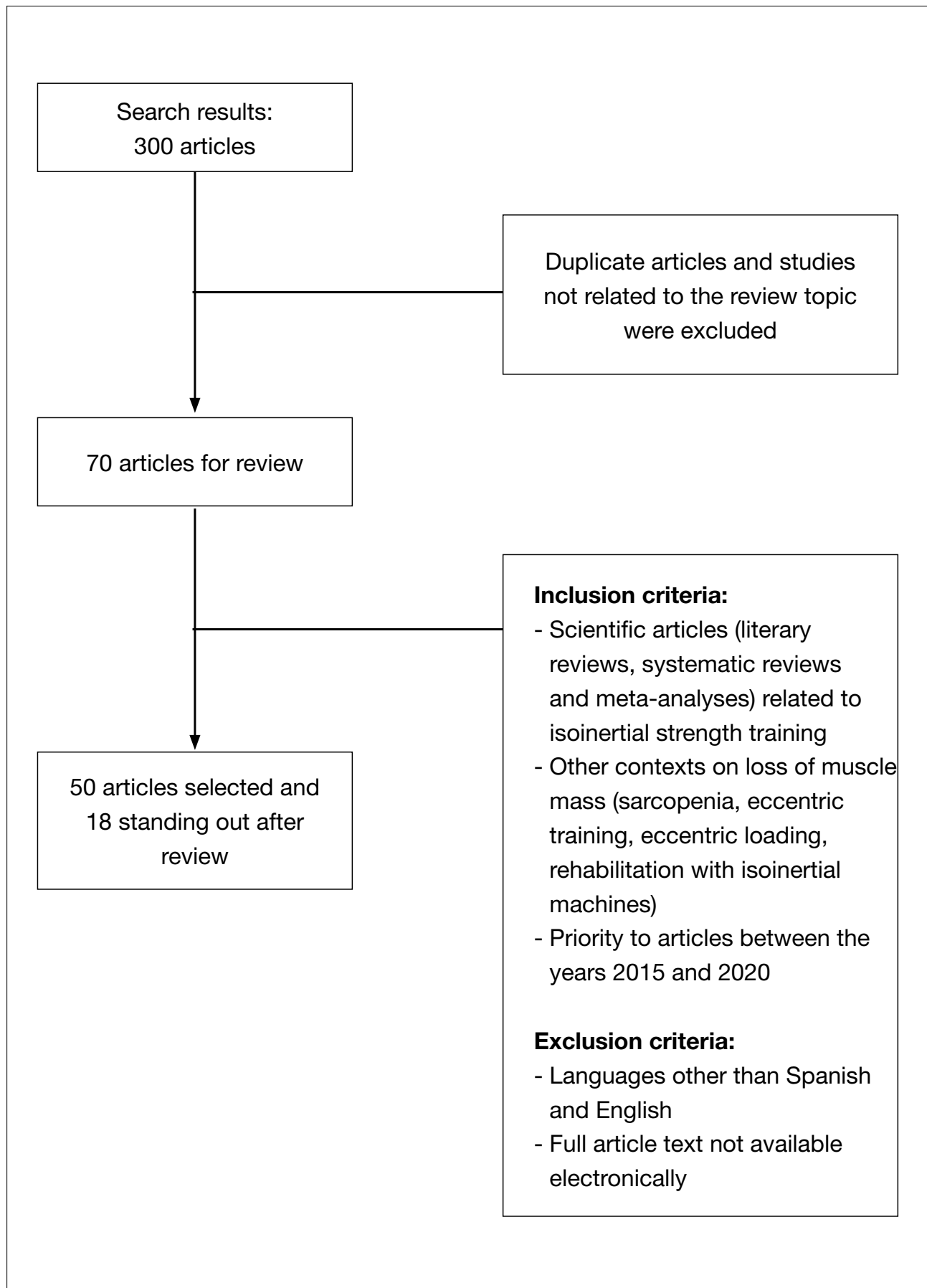
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           │              │    and meta-analyses) related to         │
           │              │    isoinertial strength training         │
           ▼              │  - Other contexts on loss of muscle      │
┌─────────────────────┐   │    mass (sarcopenia, eccentric           │
│ 50 articles selected and │  training, eccentric loading,           │
│  18 standing out after   │  rehabilitation with isoinertial        │
│       review           │    machines)                             │
└─────────────────────┘   │  - Priority to articles between the      │
                          │    years 2015 and 2020                   │
                          │                                          │
                          │  Exclusion criteria:                     │
                          │  - Languages other than Spanish          │
                          │    and English                           │
                          │  - Full article text not available       │
                          │    electronically                        │
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Figure 1
Flow chat for the article selection.

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Results

Articles on randomised clinical trials, literature reviews, systematic reviews and meta-analyses were found covering interventions using isoinertial strength training in older adults between 60 and 75 years of age, as well as those including this population in rehabilitation and sport processes, and sports-people, highlighting characteristics pertinent to neuromuscular adaptation, articles highlighted by the scientific contribution of the intervention. Likewise, the usefulness of documents related to strength training and isoinertial exercises that might be useful is highlighted (Table 1).

Table 1
Results of the neuromuscular effects of isoinertial training.

Author(s)	Year	Effects of isoinertial training (results)	Sample characteristic
(Beato et al.)	2020	Hypertrophy - Increased strength and power. Maintenance of lean mass in the face of sarcopenia	Older adults
(Kowalchuk and Butcher)	2019		Review study
(Suchomel et al.)		Maximise muscle size, strength and power	
(Bruseghini et al.)	2019	Increased anatomical cross-sectional area (quadriceps). Lean tissue preservation	Older adult subjects
(Fisher et al.)	2020	Improves muscle speed and strength. Reduces the incidence of lower limb injuries (especially the biceps femoris)	Sports and rehabilitation
(Hedayatpour and Falla)	2015	Increased passive muscle tension. Maintenance of force levels	Review study
(Illera-Domínguez et al.)	2018	Increase in strength and power in the knee (28% knee extension CIVM) - Hypertrophy of the quadriceps	Young people
(Lastayo et al.)	2017	Low energy cost - High muscle force production - Reduces losses in muscle size, strength and mobility. Reduces the risk profile for falls in older adults	Older adults
(Maroto-Izquierdo et al.)	2017	Functional and anatomical changes and improvement in performance	Sports-people
(Norrbrand et al.)	2010	Increased MVC and specific strength of the training. Higher mechanical stress	Healthy, non-active men
(Núñez et al.)	2018	Improvements in lower extremity muscle volume and functional performance	Young male team sports players
(Onambélé et al.)	2008	Increased tendon stiffness of the gastrocnemius. Improvement in the individuals' postural balance	Older adults
(Petré et al.)	2018	Increased strength and power. Hypertrophy	Sports-people
(Sañudo et al.)	2019	Improves balance, functional mobility and muscle power	Older adults
(Tesch et al.)	2017	Useful tool to improve neuromuscular function in both clinical and healthy populations	Healthy, sedentary, or physically active people and populations with muscle wasting, disease, or injury
(Tous-Fajardo et al.)	2016	Improvement in CD capacity, linear velocity, and reactive jumping	Sports-people
(Walker et al.)	2016	Increase in maximum force production, work capacity, and muscle activation	Strength-trained men
(Wonders)	2019	Muscle activation - tendon elongation and stiffness	Athletes in rehabilitation

Note. MVC: maximum voluntary contraction; CD: change of direction. Source: prepared internally.

Discussion

Sarcopenia and the older adult population

This review of isoinertial training in the older adult population has been set up in accordance with the effects of muscular and general deterioration in human beings, since, by the year 2030, it is estimated that there will be an increase of approximately 71 million adults aged 65 and over in countries like the USA who will have functional alterations due to musculo-skeletal impairment (US Census Bureau International Database, 2015). For this reason, the decrease in the practice of physical exercise has effects on muscle composition, fat mass and the progressive reduction of strength (Walston, 2012), the latter being a physiological capacity that must be kept healthy, since it is a fundamental part of the conservation of the locomotion and functional mobility of the elderly. For this reason, the loss of lean mass and the deterioration of muscle strength in adults, together with increasing age, produces a decrease in endurance capacities, which can be improved through active and healthy lifestyles (Aagaard et al., 2010; Papadopoulou, 2020; Shafiee et al., 2017).

On the other hand, the maximum muscle strength of individuals declines continuously from the fifth decade of life and increases from the seventh decade (Hughes et al., 2018; Kosek et al., 2006). This decrease in muscle strength is related to reduced motor function, mitochondrial damage, increasing age, and impaired balance, which are affected along with a greater risk of falls and bone injuries due to fractures (Campbell and Vallis, 2014; Gschwind et al., 2013; Lastayo et al., 2017). Similarly, it is strongly associated with poor health and mortality, according to studies conducted using the measurement of grip strength and the strength of the muscles of the lower extremities (Grgic et al., 2020; Newman et al., 2006; Zeng et al., 2016).

Strength training and ageing

There is evidence of strength training as an alternative and a solution to the physiological deterioration of skeletal muscle (Papa et al., 2017). This is the case for the study by Kosek et al. (2006), in which it is shown that muscle training is the most promising method to reduce or reverse the effects of sarcopenia, performing work at an intensity of 80% of a maximum repetition, which achieves satisfactory effects on the strength after 3-4 months in older adults, producing adaptations of neural properties that play a prominent role in the training

described (Fragala et al., 2019; Onambélé et al., 2008; Unhjem et al., 2015). For this reason, within strength training, along with the use of elements and machines, the isoinertial method stands out, it appears to be safe, practical and effective in increasing eccentric strength (development rate) and power (Maroto-Izquierdo et al., 2017; Núñez et al., 2018; Wonders, 2019) with overload, which allows age-related changes to be reduced and, likewise, improves the quality of life of individuals (Kowalchuk and Butcher, 2019; Lee and Park, 2013; Sañudo et al., 2019), maintaining skeletal muscle mass and improving neural stimulation through strength training as an essential factor of health and well-being (Stewart et al., 2014; Voet et al., 2019).

Similarly, when referring to the training dosage parameters, there are variables of time, intensity and speed of execution, which generate benefits in short periods (Burd et al., 2012; Cadore et al., 2014). Among them, the intensity parameter stands out as a predisposing factor in muscular adaptations towards the maintenance of nerve impulses (Fragala et al., 2019; Granacher et al., 2008; Gschwind et al., 2013; Illera-Domínguez et al. al., 2018; Kowalchuk and Butcher, 2019), which explain the best increase in strength. This is why training with isoinertial equipment favours eccentric action, which is characterised by the lengthening of the muscles (musculotendinous stretching) towards the breaking force under tension, due to the ability to apply constant and unlimited resistance through of all phases of contraction, resulting in increased power output. For this reason, the mechanical activity of acceleration and deceleration of the concentric and eccentric type through the equipment described achieves an increase in the tension (intensity) in the muscles, during contractions, according to the speed of execution and the force produced (Suchomel et al., 2019).

Eccentric strength training

Among the benefits of strength training and specifying the work on the eccentric phase, isoinertial training provides an adequate stimulus based on negative resistance (Herzog et al., 2015) in the deceleration phase of the movement and in the various squat exercises, bicep curl or knee flexion, which achieve greater neuromuscular stimuli (Katz, 1939; Meylan et al., 2008; Núñez et al., 2018; Wonders, 2019). Consequently, intervention with isoinertial devices in older adults supports the importance of its practice, adapting the musculo-skeletal system to higher rates of recruitment and impulses towards the motor unit during resisted stretching (Beato et al.,

2020; Kowalchuk and Butcher, 2019), taking advantage of positive adaptations that counteract the effects of sarcopenia (Konopka and Harber, 2014; Liao et al., 2019), improving the internal muscular environment (increase in the frequency of nerve impulses) (Camera et al., 2016; Conceição et al., 2018; Gehlert et al., 2015; Remaud et al., 2010).

Isoinertial training in older adults

The reliability and validity of isoinertial strength training in older people is a strategy that has shown significant effects at the neuromuscular level (Solà-Serrabou et al., 2019). Therefore, the eccentric muscle contraction, in conjunction with the inertial overload, generates a regulation and induction of satellite cells at the molecular level that favour better performance in the recovery of the fibrillar microinjury produced by training (Cermak et al., 2013). It also helps to maintain muscle mass together with a greater protein synthesis, caused by musculotendinous activity, which helps to support the increase in the transverse cross-sectional area and the hypertrophic effect (Hody et al., 2019). It also entails an increase in the speed, duration, tension and amplitude of concentric movement during the contraction, with a slight deceleration by the muscle of the energy (kinetic), prior to the action produced in the eccentric phase (Tesch et al., 2017).

In relation to the above, the muscle and tendon have mechanical properties that allow the production of greater force and power, as well as the generation of maximum activation at the end of the muscle lengthening or elongation phase in a higher proportion than for the concentric, leading to the effect of repeated loads causing an increase in the level of tendon stiffness with less energy expenditure, thereby generating greater efficiency of directed work within a training programme with the older adult population (Bruseghini et al., 2019; Douglas et al., 2017).

Isoinertial Machines

The isoinertial exercise modality was developed in order to prevent the loss of muscle and bone mass in astronauts as a result of the lack of gravity and the impossibility of exercising the various muscle groups, (Aboodarda et al., 2016; Petré et al., 2018; Sañudo et al., 2019), this consists of performing concentric and eccentric movements against a constant resistance (Fisher et al., 2020), generated by the action of a flywheel, which produces greater strength gains in the eccentric phase than the concentric (Petré et al., 2018; Tesch et al., 2017).

Thus, earlier, less sophisticated, isoinertial machines were developed, but they maintained the same ability to generate concentric and eccentric contractions using the same flywheel. Therefore, and thanks to technology, this methodology has been developed and applied in various general populations, not only for training purposes but also as an important aid in muscle gain in older people, who, due to age go through a process of sarcopenia, as well as in sports, physical rehabilitation (Lienhard et al., 2013) and/or cardiopulmonary procedures (Tesch et al., 2017).

In the same way, the fundamental principle of isoinertial machines is similar to the reversible toy known as a Yo-Yo (Figure 2) (Bogdanis et al., 2018; Granacher et al., 2013; Kowalchuk and Butcher, 2019; Lee and Park, 2013). This consists of a rope anchored to a flywheel system for flexion and extension movements of body parts, and the aim is to pull the rope by unrolling it from the flywheel system using springs. "The system rotates in the reverse direction, rewinding the rope, which the person performing the exercise must oppose" (Fisher et al., 2020). Consequently, the intensity of the inertia will depend on the force applied during the exercise and the diameter, and thus circumference, of the flywheel (Figures 2 and 3) (Petré et al., 2018; Sañudo et al., 2019), which increases the demands on eccentric activity after a concentric action due to the inertial loads. The work done is recorded using a rotary encoder including the various variables such as power (Watts), power range (Watts) and speed (m/s).

Figure 2
Squat isoinertial machine.

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Figure 2
Fixed radius pulley (top) and isoinertial tapered pulley (bottom).

It should be noted that the eccentric force depends on the concentric force that is applied and that, because the isoinertial activity is free of weights and the effects of the force of gravity, the machine guarantees that the energy used during both movements is practically identical; hence its name (Kowalchuk and Butcher, 2019).

On the other hand, one of the advantages of using isoinertial exercises in older adults or in people who require rehabilitation is that, with this Yo-Yo method (Petré et al., 2018), the energy cost is low (in comparison with other types of exercises for muscle gain), since the person is working in both the concentric and eccentric phases, but in the latter phase the energy expenditure is one fifth of that required in the concentric phase (Illera-Domínguez et al., 2018; Tous-Fajardo et al., 2016).

Likewise, with regard to the usefulness of isoinertial exercises, published work has shown that in adults over 70 years of age, power gains of up to 28% can be obtained (Bruseghini et al., 2019; Walker et al., 2016), managing to improve the levels of body stability and decreasing the progression in the loss of bone density (Bruseghini et al., 2019). However, no data have been found to support improvements in cardiovascular capacity in older adults (Tesch et al., 2017).

Conclusions

The isoinertial training mechanism produces positive changes to the recruitment of motor units, strength and power levels, maintaining the composition of lean tissue, neuromuscular and tendon function in older adults against the ageing process, due to the greater performance of the eccentric contraction and its progressive tension, with a low energy cost and at the same time being an effective alternative in the therapeutic and functional field.

Future directions of research

Establish the isoinertial training parameters in the methodological process to justify its application to various populations, as well as to determine the levels of inertia and the friction resistance force.

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EDUCACIÓN FÍSICA Y DEPORTES

Tactical differences between winning and losing teams in elite women's football

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Abstract

Research into women's football has increased dramatically in recent years. Despite this, in the field of collective tactical performance, publications are still scarce. The objective of this study was to analyse and describe how dynamic offensive actions came about in the winning and losing teams in the 2019 FIFA Women's World Cup in France and to establish differences between the two groups. From an observational methodology, an *ad hoc* observation instrument was developed and 1,883 offensive actions that took place in the final phase of the championship were analysed. Two types of statistical tests were carried out to verify the existence of differences between groups. The chi-square test was applied for the qualitative type criteria and the Mann Whitney U test for the continuous type criteria with a significance level of $p < .05$. The existence of significant differences was demonstrated for the following criteria: temporality, match status, total time in possession, time in possession in opponent's half, opponent's defensive organisation, wide start area and result of the action. The teams that won the matches showed a greater ability to develop their attacks in the first moments of the first and second halves, as well as a greater collective quality to maintain possession of the ball in the opponent's half and to finish their actions successfully. These results can be used with the aim of implementing training and competition strategies to increase performance in elite women's football.

Keywords: ball possession, FIFA Women's World Cup, match analysis, observational methodology, performance indicators.

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Introduction

The FIFA Women's World Cup held in France in 2019 highlighted the growth that women's football has experienced in recent years. This fact can be seen from the official report (FIFA, 2019). During the celebration of this championship, a clear improvement in the performance of the teams taking part was evident, as well as a notable growth in media interest from the spectators.

In the research field, women's football has been an understudied subject for researchers. Despite this, the number of recent publications has increased compared to previous years (Okholm Kryger et al., 2021). Currently only 25% of the publications covering football have specifically dealt with the women's game (Kirkendall and Urbaniak, 2020).

In addition to the lower number of scientific publications compared to men's football, most researchers have focused on topics related to physical fitness and injury prevention, as well as other areas related to the physiological and/or anthropometric characteristics of female footballers (Balsalobre-Fernández et al., 2015; Kirkendall, 2007; Okholm Kryger et al., 2021). For these reasons, from the point of view of tactical performance, those professionals dedicated to training and competition have been forced to extrapolate empirical conclusions from men's football to their own reality, at the expense of the differences between the two sexes' games (Bradley et al., 2014; Casal et al., 2020; Kirkendall, 2007).

Thanks to the remarkable growth in interest in this field of research, in recent years studies have proliferated with the aim of creating a solid base of knowledge to answer, among other questions, what the individual and collective technical-tactical criteria and indicators are that will enable improvement in performance in women's football. Many of these studies have been based on the analysis of performance in men's football (Amatria et al., 2019; Lago-Ballesteros and Lago-Peñas, 2010).

For performance in women's football, several authors have tried to analyse various criteria from the FIFA Women's World Cup, because this is the benchmark competition for national teams. Along these lines, Scanlan et al. (2020) analysed the criteria that were associated with the creation of scoring opportunities in the championship held in Canada in 2015. These authors verified that those actions that started dynamically, through the interception or a tackle, showed a greater probability of achieving a clear goal action compared to those preceded by a stoppage in the game. This same study also found that the duration of the attack, as well as the starting area of the attack, were significant criteria when assessing the probability of offensive success by the teams analysed. Another study carried out on this same championship was the one presented by Maneiro et al. (2020), who wanted to know how a widely studied variable in men's football (match status) could modify the development of ball possession in elite women's football. An important conclusion of this work was, without a doubt, that differences were found in how the match status modified the tactical behaviours associated with ball possession: the teams who were leading were able to maintain their tactical behaviours without being influenced by the current score, in contrast to what happened in the losing teams.

Another variable in women's football analysed was set pieces (Maneiro et al., 2019). These authors established a multivariate comparative success model based on observational methodology and came to the conclusion that the offensive success in this type of action could increase significantly depending on the number of players who intervened in the action or the area to which the ball was targeted, among other criteria.

Establishing a time jump between championships, another recent study that tried to find out what were the statistical differences between the winning and losing teams in the 2019 FIFA Women's World Cup in France was published by Kubayi and Larkin (2020). These authors tried to discern, from the statistical data extracted from the provider InStat Scout, which were the variables that differentiated the winning teams from the losers in the 48 matches analysed. They observed that the winning teams presented better data in variables related to technical performance, such as the number of passes per game, the precision of the pass and the number of shots on goal, among others. Similar differences between the sexes were found by Casal et al. (2020), when they compared the technical performance of men's and women's teams in the Spanish League. Although the study by Kubayi and Larkin (2020) assumes a reduction in the differences between winning and losing teams in a championship, the great difference in performance between the best and worst teams in women's football in the early stages (see the 13 goals that the USA scored against Thailand at this stage) can lead to difficulty in analysing the data. Finally, another interesting recent piece of research was presented by De Jong et al. (2020). It comprehensively analysed statistical data from the last seven seasons in some of the most important women's competitions in the United Kingdom and the United States, as well as European and world national team championships. These authors analysed a total of 695 matches played and observed that a large number of the variables that determined the final result

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were related to performance indicators associated with conditional aspects, such as the percentage of defensive challenges or duels won. Likewise, the most important conclusion drawn from this study was that the variable that was most positively associated with winning the match was scoring the first goal.

Because of all the above, the objective of this study was to analyse and describe how dynamic offensive actions came about in the winning and losing teams in the 2019 FIFA Women's World Cup in France and to establish differences between the two groups. To achieve this aim, two complementary types of analyses were carried out. Firstly, using a descriptive analysis we tried to establish the normal practices in these actions. Secondly, by means of a bivariate analysis, we tried to identify those criteria that differentiated the winning teams from the losing ones in this championship.

Methodology

Research design

To carry out this study, the systematic observational methodology (Anguera, 1979) was used. It was a nomothetic design, with several study units, isolated (intra-session follow-up) and multidimensional (several dimensions of the observational instrument were analysed) corresponding to quadrant III of those proposed by Anguera et al. (2011). Images from the matches were taken from public television and viewed after the event. The study was approved by the Research and Teaching Ethics Committee of the University of La Coruña (2019-0024).

Participants

The dynamic offensive actions for 13 of the 16 matches in the final phase of the 2019 FIFA Women's World Cup in France were analysed. Three games in which the final result was a draw were excluded from the study. The fact that all the matches analysed were in a direct elimination format removed any type of results speculation by the national teams. Likewise, the decision to analyse only the matches in this phase increased the equality between teams. For each of the matches, the dynamic offensive actions for the two teams were analysed.

Actions that met some of the following inclusion criteria were recorded: i) a player contacted the ball three times consecutively, ii) a pass occurred (provided the duration was greater than three seconds) or iii) a shot occurred. Offensive actions ended the moment possession

was transferred to the opposing team, or there was an interruption to the game.

Observation and recording instrument

The observation instrument used was developed *ad hoc*, it was a combination of field formats and category systems (Anguera et al., 2011).

To create the observation instrument, we followed Anguera et al's (2007) proposal. At first, a hierarchical range of behaviour units was established, which was implemented through the adoption of basic criteria for the segmentation of behaviour.

The creation of the observation instrument was based on the following pillars: i) a previous theoretical framework (in this case, the football regulations); ii) criteria and categories empirically collated in other observational studies; iii) and, finally, novel criteria that were tested in this work.

The methodological steps implemented are those proposed by Maneiro (2021), following Anguera et al. (2007). First, the problem was identified and an expert scientific group was created. This scientific group consisted of two doctors of Sports Science and teachers of football, a graduate in Sports Science with practical experience in the field, and a doctor of Psychology, with years of experience in observational methodology.

After consulting the theoretical framework and the empirical evidence, a first post-event exploratory observation was made. Then, and after a discussion by the group of experts, the problem was divided into smaller units. Subsequently, an observation instrument for a new post-event viewing was created and tested, in order to find the weaknesses in the instrument itself. Then, after another discussion by the group of experts, the observation instrument was readjusted. Finally, the post-event viewing was carried out again, to finalise the implementation of the observation instrument.

This instrument can be seen in Table 1. The criteria for the starting area in depth and spatial context of interaction were extracted and can be consulted in Castellano and Hernández-Mendo (2003). To define the categories for the initial defensive intention criterion, the definitions proposed by Casal et al. (2016) were used. The rival defensive positioning criterion was elaborated from the definitions proposed by Aranda et al. (2019) in the REOFUT observation instrument. These categories were established taking into account the collective behaviour of all the players on the team observed.

For the recording and coding of offensive actions, the Lince Plus program v 1.1.0 was used (Soto et al., 2019).

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Table 1
Ad hoc *observation instrument.*

Criterion	Category	Definition
Match result	Winner	The team observed won the match
	Loser	The team observed lost the match
Temporality of the action	1q	The action starts between the start of the game and minute 15
	2q	The action starts between minute 16 and minute 30
	3q	The action begins between minute 31 and the end of the first half
	4q	The action starts between the start of the second half and minute 60
	5q	The action starts between minute 61 and minute 75
	6q	The action starts between minute 76 and the end of the match
Match status	Winning	The team observed is winning when the action starts
	Drawn	The teams are level when the action starts
	Losing	The team observed is losing when the action starts
From depth start area	Defensive	The action begins in the defensive area of the pitch
	Pre-defensive	The action begins in the pre-defensive area of the pitch
	Midfield	The action begins in the midfield area of the pitch
	Pre-offensive	The action begins in the pre-offensive area of the pitch
	Attack	The action begins in the offensive area of the pitch
Wide start area	Left wing	The action starts from the left wing
	Central	The action starts from the centre
	Right wing	The action starts from the right wing
Opponent's defensive organisation	Organised	The opposing team is defensively organised
	Circumstantial	The opposing team is defensively disorganised
Opponent's defensive positioning	Forward	Opponents positioning is forward at the start of the action
	Midfield	Opponents positioning is midfield at the start of the action
	Rear	Opponents positioning is at the back at the start of the action

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Table 1 (Continued)
Ad hoc *observation instrument*.

Criterion	Category	Definition
Spatial context of the interaction	AA	Forward area vs. forward area
	AM	Forward area vs. midfield area
	AR	Forward area vs. rear area
	MA	Midfield area vs. forward area
	MM	Midfield area vs. midfield area
	MR	Midfield area vs. rear area
	RA	Rear area vs. forward area
	RM	Rear area vs. midfield area
	RR	Rear area vs. rear area
	PA	Goal area vs. forward area
Initial intention offensive	Progress	The team observed progresses towards the rival goal
	Maintain	The team observed maintains possession of the ball
Initial intention defensive	Recover	The opposing team shows a pressing intention to recover the ball
	Defend	The opposing team shows an intention to defend their goal
Own half P		Time of possession in own half
Opponent half P		Possession time in opponent's half
T Total		Total time of possession
Passes		Number of passes
Possession area	MD	Most possession in own half
	MO	Most possession in opponent's half
Result of the action	Goal	The offensive action ends with a goal
	Shot	The offensive action ends with a shot
	Ball into penalty area	The offensive action ends with a ball into the penalty area
	No success	The offensive action ends with failure

Data quality control

As a measure of the reliability of the *ad hoc* observation instrument, the Cohen's Kappa interobserver coefficient was calculated for the three authors of this work. To calculate this coefficient, the IBM SPSS v. 25.0 statistical package was used, following the protocol established by Losada and Manolov (2015). The average value was .869, considered excellent according to the Landis and Koch (1977) scale.

Statistical analysis

To verify the existence of differences between the winning and losing categories, corresponding to the match result criterion, two types of tests were used. First, there was a check for significant differences between the two groups of teams for the qualitative criteria. This was carried out using the chi-square test. The effect size was measured as the degree of association from the *Phi* statistic for the dichotomous

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type criteria and Cramer's V for the other criteria. For the continuous type criteria, firstly, the normality of the distributions was verified using the Saphiro-Wilk test, which was rejected. For this reason, the existence of differences between the winning and losing groups was contrasted using the non-parametric Mann Whitney U test for this type of criterion. The effect size (ES) was calculated from the formula ES = Z / $\sqrt{n}$, where Z is the standardised value of the statistic and n is the number of observations. For all tests, a level of significance of $p < .05$ was assumed.

All statistical calculations were performed with the IBM SPSS v. 25.0 package. For the graphical representations the statistical packages R and RStudio were used.

Results

A total of 1,883 dynamic offensive actions were analysed. This value represents approximately 72 actions per team and game.

Seven of the fifteen criteria analysed showed significant differences between the winning and losing categories. Table 2 shows the results for the qualitative criteria. The criteria that presented significant differences were the following: i) the temporality of the action ($p < .005$): the teams that won their matches had a higher percentage of possessions for categories 1q, 2q and 4q, compared to the losing teams, who increased their percentage of possessions in the last period of the first half and the last 30 minutes of the second half, ii) match status ($p < .001$): the winning teams were ahead on the scoreboard for 55.5% of the actions, compared to the losing teams, who, for almost 7 out of 10 actions, were behind on the scoreboard, iii) wide start area ($p < .05$): the winning and losing teams presented differences mainly in the percentage of actions initiated on the left and right wings, iv) opponent's defensive organisation ($p < .05$): the winning teams began their offensive actions against a circumstantial defence for twice the percentage observed for the losing teams (3.9% compared to 1.8%, respectively), and v) result of the action ($p < .05$): a greater number of the goal and shot categories was observed for the teams that won their matches compared to the teams that lost; the sum of both categories was 12.3% of the total actions observed for the teams that were successful at the end of the matches, compared to 8.4% observed for the losing teams.

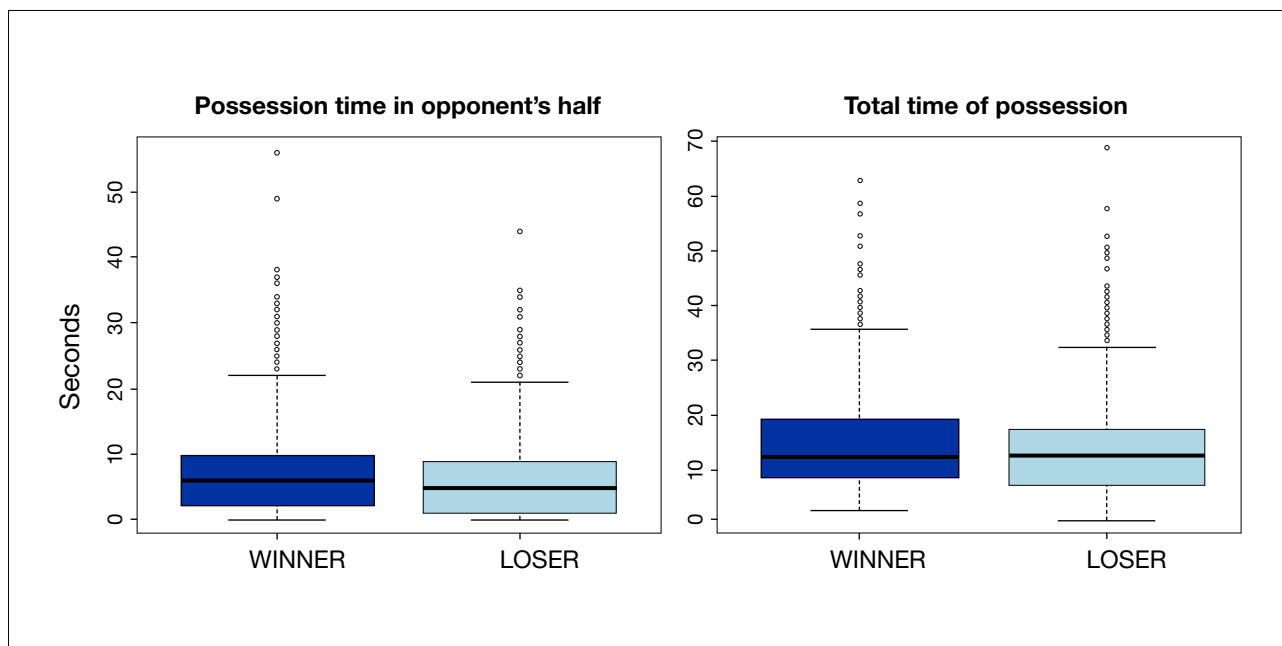**Table 2**
Bivariate analysis based on the final result.

Criterion	Category	Winner N = 903	Loser N = 980	p [ES][a]
Temporality of the action	1q	183 - 20.3%	144 - 14.7%	
	2q	158 - 17.5%	160 - 16.3%	
	3q	155 - 17.2%	175 - 17.9%	
	4q	147 - 16.3%	148 - 15.1%	.004 [.096]**
	5q	130 - 14.4%	166 - 16.9%	
	6q	130 - 14.4%	187 - 19.1%	
Match status	Winning	501 - 55.5%	3 - 0.3%	
	Drawn	365 - 40.4%	310 - 31.6%	<.001 [.75]***
	Losing	37 - 4.1%	667 - 68.1%	
From depth start area	Defensive	127 - 14.1%	157 - 16.0%	
	Pre-defensive	308 - 34.1%	330 - 33.7%	
	Midfield	246 - 27.2%	276 - 28.2%	.449[-]
	Pre-offensive	195 - 21.6%	183 - 18.7%	
	Attack	27 - 3.0%	34 - 3.5%	

Note. * $p <.05$ ** $p <.005$ *** $p <.001$ [a]Effect size.

Table 2 (Continued)
Bivariate analysis based on the final result.

Criterion	Category	Winner N = 903	Loser N = 980	p [ES][a]
Wide start area	Left wing	221 - 24.5%	211 - 21.5%	
	Central	493 - 54.6%	506 - 51.6%	.009 [.07]*
	Right wing	189 - 20.9%	263 - 26.8%	
Opponent's defensive organisation	Organised	868 - 96.1%	959 - 98.2%	.008 [.061]*
	Circumstantial	35 - 3.9%	18 - 1.8%	
Opponent's defensive positioning	Forward	399 - 44.2%	449 - 45.9%	
	Midfield	159 - 17.6%	185 - 18.9%	.381[-]
	Rear	345 - 38.2%	344 - 35.2%	
Spatial context of the interaction	AA	13 - 1.4%	20 - 2%	
	AM	7 - 0.8%	3 - 0.3%	
	AR	82 - 9.1%	69 - 7%	
	MA	4 - 0.4%	4 - 0.4%	
	MM	7 - 0.8%	15 - 1.5%	
	MR	374 - 41.5%	385 - 39.3%	.212[-]
	RA	18 - 2.0%	14 - 1.4%	
	RM	279 - 30.9%	341 - 34.8%	
	RR	28 - 3.1%	37 - 3.8%	
	PA	90 - 10%	92 - 9.4%	
Own half P		5 [0-11]	6 [0-11]	.966[-]
Opponent half P		6 [2-10]	5 [1-9]	.021 [.05]*
T Total		12 [8-19]	12 [7-17]	.033 [.04]*
Passes		3 [2-5]	3 [2-5]	.816 [-]
Initial intention offensive	Progress	383 - 42.4%	417 - 42.6%	.952[-]
	Maintain	520 - 57.6%	563 - 57.4%	
Initial intention defensive	Recover	575 - 63.7%	599 - 61.2%	.263[-]
	Defend	327 - 36.3%	379 - 38.8%	
Possession area	MD	444 - 49.3%	485 - 49.5%	.910[-]
	MO	457 - 50.7%	494 - 50.5%	
Result of the action	Goal	18 - 2%	5 - 0.5%	
	Shot	93 - 10.3%	77 - 7.9%	.006 [.081]**
	Ball into penalty area	127 - 14.1%	144 - 14.7%	
	No success	665 - 73.6%	754 - 76.9%	

Note. * p < .05 ** p < .005 *** p < .001 [a]Effect size.

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Figure 1
Total time of possession and time of possession in opponent's half based on the result.

On the other hand, two of the four continuous-type criteria analysed presented statistically significant differences between the two groups of teams: total time of possession ($p < .05$) and possession time in the opponent's half ($p < .05$). For both criteria, the time in possession was slightly higher for the winning teams compared to the losing teams. The distributions of both criteria can be seen in Figure 1.

Discussion

The objective of this study was to analyse and describe how dynamic offensive actions came about in the winning and losing teams in the 2019 FIFA Women's World Cup in France and to establish differences between the two groups. A study was proposed based on the systematic observational methodology in which 1,883 dynamic offensive actions in 13 matches of the final phase of that championship were analysed.

Seven of the fifteen criteria that made up the observation instrument presented significant differences related to the final result of the game analysed.

The criterion that presented the greatest degree of association with the result of the match was the temporality result ($p < .001$). The relationship between both criteria agrees with that observed by Maneiro et al. (2020) after analysing ball possessions at the 2015 FIFA Women's World Cup in Canada. It seems logical to think that the team that manages to win their matches tends to be ahead on the scoreboard for the longest time and vice versa. In any event,

the fact that only three offensive actions were recorded when the losing team was ahead is significant, since it seems to establish a clear relationship between scoring the first goal in the match and the final result. This fact has already been observed by De Jong et al. (2020), who concluded that getting ahead on the scoreboard was the element that most affected the outcome of elite women's football matches. At the FIFA Women's World Cup, nine out of ten teams that took the lead won their matches (FIFA, 2019). This highlights the difficulty of overcoming a deficit in women's football matches, as well as the superiority of the best teams throughout the match in terms of the scoreboard.

The temporality criterion showed significant differences between the two groups of teams. A common trend in elite football could be observed: losing teams increased the number of actions in the last periods of the first and second half. In this sense, it was observed that there is a certain tendency, more marked in the last 30 minutes of play, for the winning teams to assume a more defensive collective role in order to protect their goal and advance to the next phase. The winning teams, however, were able to create a greater number of offensive actions in the first five minutes. This fact can be justified by a higher individual and collective quality in the winning teams, reflected in variables such as passing precision (Kubayi and Larkin, 2020), for which, during the first minutes of the match characterised by a higher intensity and less tactical control, they are able to impose themselves by controlling ball possession to a greater extent.

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On the other hand, differences were found in the time of possession between the winning and losing categories. The total time in possession criteria ($p < .05$) and possession time in the opponent's half ($p < .05$) were higher for the winning teams. This is logical, perhaps due to a greater collective quality when it comes to maintaining possession, even more so when it happens in the opponent's half. This is an important fact, since possession in the opponent's half has been shown to be an indicator that is positively associated with performance in men's football (Casal et al., 2017). The reduction of time and space for deciding and executing in the opponent's half, in which the density of players is greater, proved to be a criterion that differentiated the winning and losing teams in this championship. In addition, an important fact for a team to be able to keep possession of the ball away from their own goal is the option of quick pressure after a loss and to regain possession more quickly than the opponents, thus preventing the opposing team from gaining control of the ball.

As far as the collective ability to develop positional play is concerned, this has improved during in this latest championship, as shown by the increase in the average percentage of passing accuracy compared to other championships (FIFA, 2019). Despite this improvement, a criterion that has shown differences between the groups analysed has been the opponent's defensive organisation. This criterion was observed and recorded at the exact moment of initiating the offensive action. Therefore, those actions that began in the face of a circumstantial defence must normally have been preceded by a loss of the ball by the rival team. This explains the temporary impossibility of reorganising defensively and executing an effective defensive transition. Kirkendall (2007), after interviewing elite female coaches, suggested a differential characteristic between players: the coaches observed a lower technical performance for defensive players compared to players in more forward positions. This fact can make it difficult for women's teams when developing positional play from areas close to their own goal, running a high risk of losing possession of the ball and giving the opposing team a favourable moment of offensive transition in front of the goal. The fact that the winning teams started 3.9% of their offensive actions against a circumstantial defence, compared to the 1.8% observed for losing teams could be a clear indicator of the final performance in matches and offensive actions, as Casal et al. (2016) found for men's football.

The last criterion that presented significant differences was the result of the action. Differences were observed between the two groups of teams analysed for the categories that imply a greater offensive success. Thus, the teams that won the matches managed to finish 12.3% of their offensive actions with a goal or a shot on goal. This value was four percentage points higher than for the losing teams. Although this difference may seem small, it must be assessed in relation to its low frequency: in the championship analysed, the teams that won their matches took approximately 15 shots per game, compared to the 8 taken by the losing teams, although the relative difference was higher in the analysis of shots on target: 6.38 shots on target versus 2.79 for the winning and losing teams, respectively (Kubayi and Larkin, 2020).

Conclusions

Differences were found in the criteria analysed between the winning and losing teams at the 2019 FIFA Women's World Cup in France. The teams that won their matches showed a greater capacity to maintain possession of the ball, even more so in the opponent's half, and to have a greater number of possession of the ball in the first periods of the first and second halves. Similarly, the best teams were able to initiate their offensive actions to a greater extent against an opponent's circumstantial organization, highlighting a higher performance when provoking this type of action or, likewise, a lower performance on the part of the losing teams when it comes to developing effective positional play in areas close to their own goal. On the other hand, the fact that the teams that went ahead on the scoreboard were able to achieve a favourable match result was corroborated, and differences were found in the effectiveness of the offensive actions by both groups of teams: teams that won the matches were able to finish their actions with a goal or shot significantly better than losing teams. These results allow tactical differences between winning and losing teams to be established and allow coaches and selectors to implement training and competition strategies to improve performance in international competitions. Along these lines, it is suggested that training tasks be elaborated in which ball possessions are carried out in confined spaces, as close as possible to the opponent's goal, of short duration, that allow the development of dynamic offensive actions without fatigue, in which the structures of female football players favour an optimal tactical development at the various moments of the game. Likewise, it is suggested that there is a need to implement optimal pre-game warm-up strategies that allow teams to impose their gameplay during the first minutes of play.

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Multivariable analysis of key performance indicators in rink hockey

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Abstract

This study aimed to analyse the influence of various game variables on the final result of rink hockey matches. The influence of the game location, scoring the first goal of the match, winning at halftime and winning at halftime were analysed. A total of 480 matches of the Spanish first division (OK Liga) played during the 2017-2018 and 2018-2019 seasons were analysed. The logistic regression analysis showed that the variable with a stronger association with victory was leading at half time by more than one goal (OR 4.47). In addition, the variables winning at half time (OR 3.35), scoring first (OR 2.05) and game location (OR 1.83) were also factors showing association with the final result of the match. The factors identified could help rink hockey coaches and players better tailor their training strategies and objectives before each competition, establishing a better knowledge and understanding of the game.

Keywords: game variables, performance analysis, performance factors, roller hockey, situational variables, team sports.

Introduction

Sports science has recently focused on the quantitative analysis of technical and tactical actions in various sporting specialities with the aim of establishing correlations related to sporting success. Performance analysis, defined as the study of behaviour in competitive sports, seems to be widely accepted by coaches, sports science researchers and players, as well as being a suitable procedure to analyse and improve performance (Drust, 2010; Liu et al., 2016). In this sense, a performance indicator is defined as a selection or combination of variables that aim to define some or all of the aspects that can improve that sporting performance (Hughes and Bartlett, 2002). Therefore, it seems necessary and useful to identify and quantify which performance indicators are relevant to each sport, mainly for team sports. In recent years these have been widely studied in basketball, handball and football (Diana et al., 2017; García-Rubio et al., 2015b; Lago-Peñas, et al., 2016a; Prieto et al., 2015). Many of these contributions have identified influential variables such as the time in possession of the ball (Gómez et al., 2015), the sending off of players (Gómez et al., 2018; Lago-Peñas et al., 2016b), the location of the match (Pollard et al., 2017), the effect of substitutions (Gómez et al., 2016; Gómez et al., 2017), and the time a goal is scored (Baert and Amez, 2018).

One of the game variables that has been shown to have a great influence on the performance of the teams is the home advantage (HA), the advantage of playing at the team's own ground (Prieto et al., 2013). HA is defined as the advantage that teams have when playing on their own pitch as opposed to their opponent's, relating the percentage of points that teams win when they play at home to the total points scored in the competition (Pollard, 1986). This metric provides information on the effect of competing as the home team or as the visitor on the result of sporting competitions. Some studies have identified the factors that could explain this phenomenon, such as, for example, the adverse effects of travel fatigue, familiarity with the pitch, refereeing bias, territoriality and the effect of the local spectators (Courneya and Carron, 1992). In this sense, the HA phenomenon has been demonstrated in individual sports such as tennis (Koning, 2011), judo (Brito et al., 2017; Ferreira Julio et al., 2012), speed skating (Koning, 2005) and golf (Nevill et al., 1997), as well as in collective sports such as football (Gómez and Pollard, 2014; Pollard, 2006), basketball (Pollard and Gómez, 2013; Ribeiro et al., 2016), rugby (Mcguckin et al., 2015; Thomas et al., 2008), handball (Prieto and Gómez, 2012) and water polo

(Prieto et al., 2013). Although the value of HA can vary between different sports, regions or levels of competition, in general terms its effect on team sports is quantified at around 60% (Jamieson, 2010). To our knowledge, only two studies have previously analysed the phenomenon of HA in rink hockey, which has also quantified it with an approximate value of 60% (Arboix-Alió et al., 2020; Arboix-Alió and Aguilera-Castells, 2019).

Another variable that can influence the performance of the teams is the time at which goals are scored, a situation that leads to a change in the score (Leite, 2013). According to the psychological momentum theory (Gayton et al., 1993; Iso-Ahola and Mobily, 1980), scoring the first goal in a match can provide an added advantage. This happening, which comes about when an initial successful event occurs in a sporting context, produces a psychological momentum in the sports-person that leads to later success. Some football research has established that the team that scores first significantly increases its chances of winning (Courneya, 1990; Jones, 2009; Lago-Peñas, et al., 2016c; Leite, 2013; Sampedro and Prieto, 2012). Another significant factor related to the time of scoring is that the teams that are winning at the end of the first half of the game are more likely to win (Cooper et al., 1992; Martínez, 2014). In rink hockey, scoring the first goal of the match has also been shown to be a significant indicator for competitive performance (Arboix-Alió and Aguilera-Castells, 2018). Similarly, the effect and interaction of various situational variables on the final result have been analysed in order to identify the critical moments in the game (García-Rubio et al., 2015a; Lago-Peñas and Dellal, 2010; Lago et al., 2010), and a significant correlation has been shown between winning the match and scoring first for teams playing at home.

Although it has been studied in other sports, no research has been found that has focused on the establishment of a predictive model for rink hockey that uses multivariable regression analysis to examine the contribution of the main performance indicators to the final result of the matches. Therefore, this study aimed to study the effects that the following game variables may have: match location, scoring first, winning at half-time and winning at half-time by more than one goal to the final result of the rink hockey matches in top level Spanish competition. As a secondary aim, it was suggested that the various predictive variables be compared to understand which are the most influential factors in the final result.

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Methodology

Sample

To carry out this study, 480 rink hockey matches were analysed. All the matches were from the 2017-2018 and 2018-2019 seasons of the Spanish first division of men's rink hockey (OK Liga). Many of the players playing in this league have played in international competitions, both at club level and with the national team, with Spain being the most successful team in these competitions, with a total of 17 world cups and 17 European championships.

The Spanish rink hockey league (OK Liga) is based on a regular home and away league system, in which the same number of games are played at home and away from home. In the OK Liga, a winning team receives three points, a drawing one receives one point, and no points for a loss. The data collection procedure was carried out using the information available for each match on the official website of the Spanish Skating Federation (www.fep.es).

Variables

The result of the match was established as the dependent variable for the study, expressed as the goal difference between the two teams. Four independent variables were examined to identify their influence on the match result: a) winning at half time (WH), 0 = not winning at half time, 1 = winning at half time; b) Game Location (GL), 0 = away, 1 = home; c) scoring first (SF), 0 = scoring first, 1 = not scoring first; d) winning at half time by more than one goal (WHG), 0 = not winning at half time by more than one goal, 1 = winning by two or more goals.

Statistical analysis

The main variable for the study was the result of the match (not winning, winning). A univariate analysis was performed for each of the variables related to the match result, using the χ^2 test with Yates' correction for categorical variables. Statistical significance was established at $p < .05$. The variables were subjected to a multivariable analysis using a logistic regression (Hidalgo and Goodman, 2013). A predictive model based on four variables was established. In the final model, the match result was coded as no victory = 0, victory = 1, considered, as we have mentioned previously, as the dependent variable.

Logistic regression was used to predict the categorical results based on the predictor variables for the matches (Pic and Castellano, 2016, 2017). Four independent variables were included in the model: WH, SF, GL, WHG. The dependent variable used in this model was Y [0.1]. The value of the dependent variable was one for winning the match and zero for not winning the match. The final equation for the model was established as follows:

$$P(Y) = \frac{1}{(1+e-(MO= \beta1+\beta2\cdot WH+\beta3\cdot SF+\beta4\cdot GL+\beta5\cdot WHG+\beta i))}$$

The odds ratio (OR) and 95% confidence intervals were calculated from beta coefficients and the standard error. The ORs showed the change in the probabilities, which means that if the value was greater than one the probability of winning increased. Likewise, if the value was less than one the probability decreased. The hypothesis that the logistic model fits the data adequately was tested using the χ^2 goodness-of-fit test (Hosmer and Lemesbow, 1980). Statistical analysis was performed using the SPSS program (version 20 for Windows; SPSS Inc., Chicago, IL, USA).

Ethical considerations

As the study was carried out in the setting of an official competition for public broadcast, the informed consent of the athletes was not required, in accordance with the ethical requirements established by the American Psychological Association (2002).

Results

Table 1 shows the descriptive and percentage statistics of all the games played in the OK Liga during the 2017-2018 and 2018-2019 seasons. The teams that were ahead at half time won 76.21% of the matches, while, when they were drawing or losing, this percentage decreased to 11.35% and at 12.43%, respectively. In addition, home teams that were ahead at half time ended up winning 83.5% of the matches. By contrast, visiting teams won 68.54% of matches when they were ahead at half time.

All the performance indicators analysed showed significant differences between wins (winning) and draws or losses (not winning) (Table 2). The presence of any of the performance indicators studied was linked to a higher number and percentage of wins. In general, the WHG

Table 1
Percentage of wins, draws and losses as a function of the result at half time.

	Result full Time	Win			Draw			Loss		
		Home	Visitor	Total	Home	Visitor	Total	Home	Visitor	Total
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Result at half time	Win	162 (83.5)	120 (68.54)	282 (76.21)	16 (8.25)	26 (14.16)	42 (11.35)	16 (8.25)	30 (16.85)	46 (12.43)
	Draw	40 (36.36)	36 (32.72)	76 (34.54)	34 (30.9)	34 (30.9)	68 (30.9)	36 (32.72)	40 (36.36)	76 (34.54)
	Loss	30 (16.85)	16 (8.25)	46 (12.43)	26 (14.16)	16 (8.25)	42 (11.35)	120 (68.54)	162 (83.5)	282 (76.21)

variable resulted in 93.3% of winning and a 6.7% of not winning ($p < .001$); WH resulted in a 76.2% of winning and a 23.8% of not winning ($p < .001$); SF in 62.5% of winning and a 37.5% of not winning ($p < .001$), and GL in 49.2% of winning and a 50.8% of not winning ($p = .004$).

After multivariable analysis, the results showed that all the variables analysed had a positive effect on the end result of the match (Table 3). WHG was the most powerful

predictor variable, with an OR value of 4.695. The second variable was WH with an OR of 3.348, followed by SF (OR = 2.058) and GL (OR = 1.828).

In the model, establishing a cut-off point of 0.420 to predict a win resulted in a sensitivity of 0.6692, a specificity of 0.8301, a positive predictive value of 73.61%, a negative predictive value of 77.98% and a total correct classification of 76.73%.

Table 2
Descriptive statistics and percentage of game variables on the result of the game.

	Match result		p
	Win	Not a win	
	n (%)	n (%)	
Leading at half time	282 (76.2)	8 (23.8)	.000**
Scoring first	289 (60.6)	188 (39.4)	.000**
Location of the match	235 (49.2)	243 (50.8)	.001**
Leading at half time by more than one goal	154 (87)	23 (13)	.000**

Note. ** Significant differences between the game variables and the final result; $p < .01$

Table 3
Results of the multivariable analysis. Effects of leading at half time, scoring first, location of the match and leading at half time by more than one goal.

	Model coefficients	Significance value	Odds ratio	Confidence interval of the odds ratio (95.0%)	
				Lower	Upper
Winning at halftime	1.208	.000	3.348	2.234	5.018
Scoring first	.722	.002	2.058	1.433	2.955
Game location	.605	.000	1.828	1.354	2.469
Winning at half time by more than one goal	1.546	.000	4.695	2.757	7.993
Constant	-1.795	.000	.166		

Note. Goodness of fit $\chi^2 = 7.218$; df = 6; $p = .301$. Area under the ROC curve = 0.81; sensitivity = 0.6692; specificity = 0.8301; PPV = 0.7361; NPV = 0.7798.

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In Figure 1, the ROC curve is shown for the multiple logistic regression model based on the variables of the match result, indicator of the representation of the ratio or proportion of true positives (RVP) versus the ratio or proportion of false positives. (RFP).
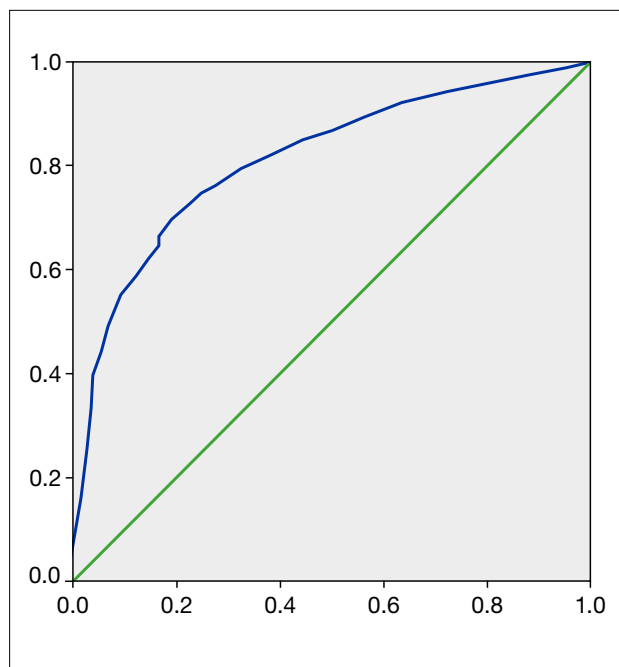

Figure 1
ROC curve for the multiple logistic regression model based on the match result variables. Area under the ROC curve = 0.81.

Discussion

The main objective of this study was to identify the variables related to the final result of matches in the Spanish men's first division of rink hockey and their specific importance by means of a multivariable analysis. The results obtained showed that the variables game location (GL), scoring first (SF), winning at half time (WH) and winning at half time by more than one goal (WHG) have an independent predictive effect related to the final result of the match. The strongest predictor variable was WHG (OR = 4.695), followed by WH (OR = 3.348), SF (OR = 2.058) and GL (OR = 1.828). These findings confirmed that the evolution of the score clearly influenced the results of rink hockey matches. No previous studies have been found in this sport that allow us to compare our results. However, they coincide with those reported for other team sports such as football, where teams also get better results when they are winning at half time (Martínez, 2014).

Winning at half time

The study results showed that 76.2% of the victories corresponded to teams that were winning at half time. The logistic regression showed that the WH variable provided a positive effect quantified with an OR of 3.348. However, the most powerful predictor in our study was the WHG variable, which produced an OR of 4.695. There may be several reasons for these findings. One of them would be that the fact of being ahead in the game creates a state of comfort that allows players to adopt strategies to maintain possession of the ball during the second half, which translates into a less direct style of play and therefore a greater control of the game (Lago et al., 2010). In this sense, it has been shown that, in sports with a formal structure similar to rink hockey, such as football, teams play differently depending on whether they are losing, winning or drawing (Lago and Martín, 2007).

Scoring the first goal

Another performance indicator predictor of victory was the variable SF, with an OR of 2.058. The results showed that the teams won 60.6% of matches when they scored first. According to previous studies, such as that of Arboix-Alió and Aguilera-Castells (2018), which quantified the advantage of scoring first in Spanish men's professional hockey at 64.14%, or like others on team sports, scoring first is relevant because a team that is level or behind reduces attempts to score a goal (García-Rubio et al., 2015a; Taylor et al., 2008). In football, García-Rubio et al. (2015a) found an OR of 3.36 for teams that score the first goal in a match. The lower OR value found in this study could be explained by rink hockey being a sport with a higher number of goals per game than football, with an average of 7.13 goals in the Spanish league (Arboix-Alió and Aguilera-Castells, 2019) as against only 2.65 in Spanish futsal (Sampedro and Prieto, 2012) or 3.61 and 3.55 in the football world cups and the UEFA European championships played in the 2010s. Contrary to what happens in football, the data indicate a greater difficulty for rink hockey teams to maintain a favourable result when they score first. However, the advantage of scoring first could be explained for the same reasons as in other team sports.

Scoring the first goal of the match also has a positive impact on the home crowd, increasing their enthusiasm and participation. This effect is based on the theory of psychological momentum (Gayton, et al., 1993;

Iso-Ahola and Mobily, 1980), known to be the added advantage obtained when a successful initial event occurs in a sporting context, providing a psychological momentum to the sports-person that leads to improvements in performance and increases their chances of success. This phenomenon is also thought to explain the ups and downs in the performance of teams and players (Roane et al., 2004) in various situational sports such as football, baseball or beach football (Courneya, 1990; Lago-Peñas et al., 2016c; Leite, 2016).

Game location

Finally, the predictor that least affected the final result, although it was also statistically significant, was the variable GL, with an OR of 1.828. The effect of HA in rink hockey has been confirmed in recent studies, and has been estimated to be around 60% (Arboix-Alió et al., 2020; Arboix-Alió and Aguilera-Castells, 2019). Playing at home can have a psychological effect on players who experience a response in their behaviour to protect their own territory (Pollard and Gómez, 2009). According to the theory of territoriality and social facilitation, local teams show more aggressive behaviour to intimidate and dissuade their rival, thus conditioning the visitor's performance (Prieto and Gómez, 2012). Other extrinsic factors that can influence HA are the size of the crowd, the conditions of the trip, the refereeing or familiarity with the pitch (Courneya and Carron, 1992; Pollard and Pollard, 2005).

The differences found between the four predictive variables in this study can be explained by the intrinsic characteristics of rink hockey. In the Spanish rink hockey league there are an average of 7.13 goals per game (Arboix-Alió and Aguilera-Castells, 2019), which means that scoring first is not as decisive as in other team sports in which the number of goals is considerably lower (García-Rubio et al., 2015a). However, leading at the end of the first half and leading by more than one goal seem to be the two most determining factors for victory. Logically, the sum or combination of these four variables further increases the chances of predicting victory in a match, for example, scoring first, along with playing at home and being ahead at the end of the half.

This study also has some limitations that should be addressed in future research. On one hand, the possible effects of some factors such as refereeing bias (Sors et al., 2020), the influence of travel and competitive balance have not been considered (Arboix-Alió et al., 2019; Arboix-Alió, et al., 2021) or crowd behaviour (Pollard,

2008). On the other hand, future research should confirm our results in other competitive rink hockey contexts, such as, for example, in the women's league, in the main national leagues (for example, the Italian league or the Portuguese league) or in competition at a lower level (grassroots sports or regional leagues). Similarly, it would be interesting to analyse whether these game variables change according to the relevance of the competition (European and world championships and the Euroleague) or to study the effect on specific actions in the game, such as set-piece actions (Fernández-Hermógenes et al., 2017, 2021) or the intervention of the goalkeeper (Trabal, 2016; Trabal et al., 2020).

Conclusions

This study has identified, in decreasing order, the following predictive values for victory in the matches of the Spanish rink hockey league: winning at half time by more than one goal, winning at half time, scoring first and playing at home. These results show the importance of dominating the score at the end of the first half. Further, initial sporting events such as scoring first also appear to affect the outcome and play in rink hockey matches. As practical applications of this research, the analysis of the influence of the game variables can provide valuable information to coaches and practitioners in this sport in aspects such as team selection according to the needs of the team itself, the characteristics of the opponent, the point in the match and the match location. Therefore, coaches should design training to reinforce the pressure in attack at the beginning of the game, forestalling the opposing team to achieve a lead at half time and not to concede any goals.

Playing at such a high rhythm to maintain competitive advantage also implies proper management of the team's physical preparation, requiring a physical condition that allows optimal technical and tactical performance under high demands, coping with accumulated fatigue (Fernández et al., 2020). Furthermore, these findings could help technical team members to design specific training sessions based on specific game situations and also to simulate various game scenarios where there is a scoring advantage or disadvantage. These hypothetical situations could be useful to analyse the individual responses of the players in these situations and to improve their performance in pressure situations. For this reason, it is advisable to apply psychological alternatives that allow optimizing sports performance in times of pressure inherent in competitive sports.

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Profile of mountain bikers. Trotamons Bike Race

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Abstract

In recent years there has been an increase in the practice of open-air physical-sporting activities in Spain, among which we find the speciality of mountain biking (MTB). The objectives of the study were to advance the generic characterisation of MTB practitioners in order to identify relevant aspects that favour the promotion and management of this sporting speciality. The methodology used consisted of distributing a questionnaire among the participants in the popular Trotamons Bike Race 2019 event (N = 461). Among the main results obtained, the identification of a somewhat uniform profile characterised by being: men, middle-aged, with a medium-high educational level, salaried, married or with a partner, with more than 5 years practising this sport and with a low level of environmental sensitivity. The results obtained were discussed as they relate to the management and promotion of this sporting speciality.

Keywords: events, mountain biking (MTB), practitioners, practitioner profile, sports speciality.

SPORTS MANAGEMENT, ACTIVE LEISURE AND TOURISM

Introduction

Mountain biking (MTB) is a cycling speciality undertaken in a natural environment with a mountain bike (RFEC, nd).

During the last two decades, there has been a change in the perception of physical-sports activities in the natural environment by the general population. Practices that were previously the reserve of minority groups, have, in a few years, come to be seen as one more alternative for the active use of free time. As a result of this expansion, there have been significant changes, not only in social behaviour, but also in the perception and effect that this type of activity has on the natural environment (Inglés et al., 2016; Luque-Gil, 2011; Olivera and Olivera, 1995; Sans and Inglés, 2021).

It is worth mentioning that, according to the data available in the latest survey of sporting habits in Spain (MECD, 2015), it is estimated that more than 53% of the Spanish population regularly practices some type of physical-sports activity, of whom almost 46% usually do it outdoors. Data which, in this case, agrees with the figures published in the latest Eurobarometer (European Commission, 2018), especially for the practice of physical-sporting activities in the open air, which places Spain, with 53%, in third position, behind Finland (67%) and Austria (54%). On the other hand, according to data from the Ministry of Education and Vocational Training (MECD, 2015), more than 63% of those surveyed living in Spain declared that they have a bicycle at home. Therefore, it is not surprising to find cycling (in all its variants) among the four most practised types of sport, at 38.7%, ahead of swimming (38.5%), hiking/mountaineering (31.9%) and running (30.4%).

One more example of the relevance of mountain biking can be found in the proliferation of sporting events that include this sport. As an example, as shown in Figure 1, see the increase in the number of events registered on one of the most popular web pages for the publicising of this type of sporting event nationwide. While the number of events registered was 62 in 2010, by 2019 this number reached some 1,800, which represents an annual growth rate (CI) of 52%, with peaks in the years 2011 and 2013, with an increase of around 153% and 172%, respectively.
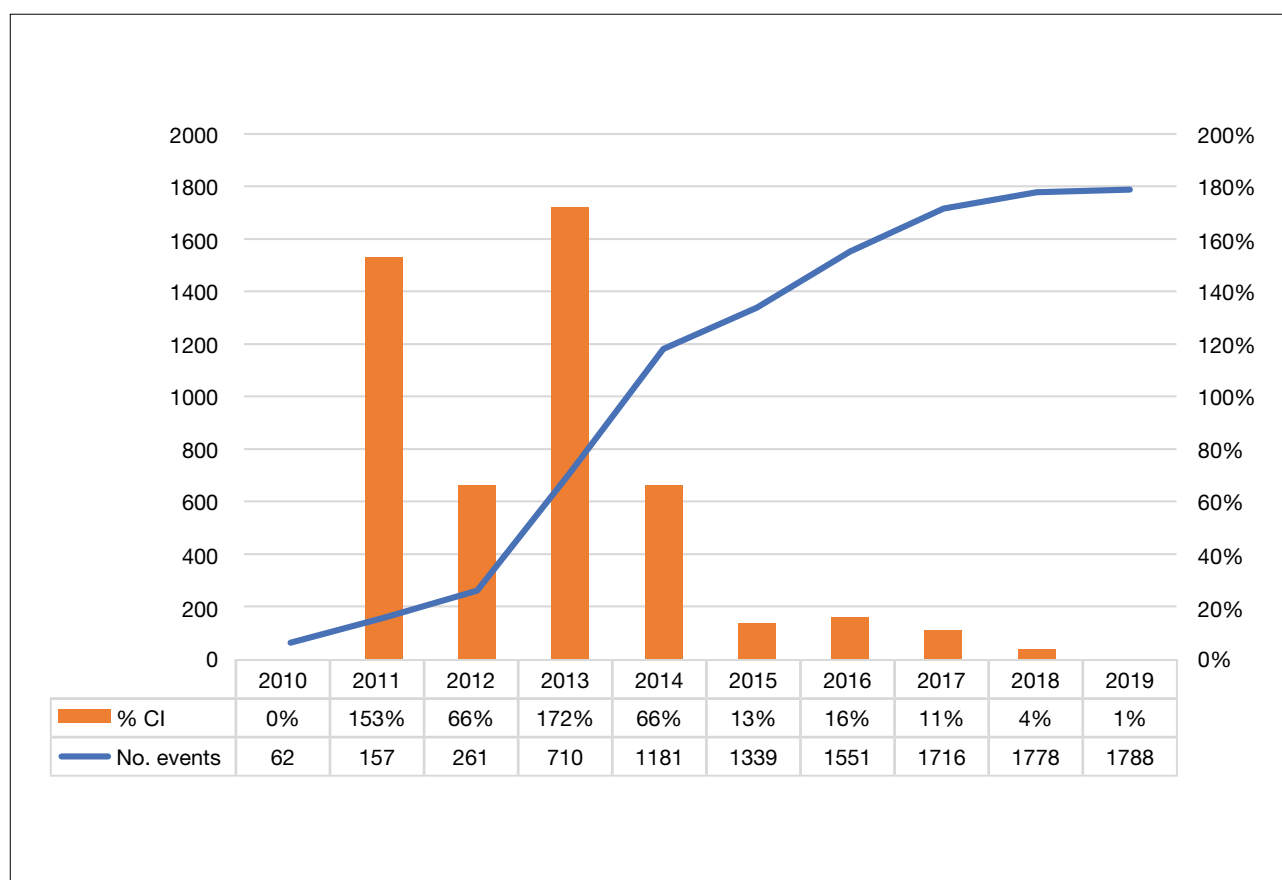

Figure 1
Evolution and annual increase (%) of mountain biking (MTB) events in Spain.
Source: produced internally, based on data provided by the Runedia website (2019).

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
% CI	0%	153%	66%	172%	66%	13%	16%	11%	4%	1%
No. events	62	157	261	710	1181	1339	1551	1716	1778	1788

At a more specific level, and with respect to the study of the practitioners themselves, it is worth highlighting the existence of a varied group of studies that have tried to advance the knowledge of this sporting speciality by addressing various aspects, such as: identification of the main motivations for practising or participating in events by the practitioners of this sporting specialty (Bordelon and Ferreira, 2019; Getz and McConnell, 2011; Kruger et al., 2016; Santos et al., 2016; Taylor, 2010), or the environmental consequences caused by the practice of this speciality (Evju et al., 2021; Farías-Torbidoni, 2015; Morey et al., 2002; Mueller et al., 2018; Newsome and Davies, 2009; Pickering et al., 2011), in addition to the classification of the health benefits that can come from this sport (Roberts et al., 2018).

At this point, it is worth highlighting the diversity of results found in the study of the motivations for participating by authors such as Santos et al. (2016), Taylor (2010), Bordelon and Ferreira (2019), Getz and McConnell (2011) and Kruger et al. (2016). While the studies by Santos et al. (2016) and Taylor (2010) into the motivations for participating in general do not agree with each other, possibly due to the use of different methodologies (quantitative and qualitative), they do do so when compared with the results obtained by Bordelon and Ferreira (2019), Getz and McConnell (2011) and Kruger et al. (2016) into the analysis of the motivations derived from the participation in MTB events.

From a more global perspective, it is also interesting to highlight the studies carried out by Cessford (1995), Seguí-Urbaneja et al. (2020) and Rejón-Guardia et al. (2020), which, despite having been carried out in different contexts (international, regional and national) and in different years, provide interesting data on age, gender, years of experience and even frequency of practice, with special relevance to the presence of certain constants such as a clear predominance of male bikers with a medium-high level of training and with a weekly frequency of practice of between once and twice.

However, despite the existence of a large number of studies, at both the international and national level, there are few studies that have addressed in depth the identification of the generic profile of these practitioners at the national level, so important when deploying any type of promotional or commercial activity policy for this sport, especially for the speciality of mountain biking.

Starting from here, the objectives that were set in the performance of this study were to advance the characterisation of the generic profile of MTB practitioners, specifically their motivation, habits and preferences in practicing and participating in sporting events, and to identify aspects relevant to the promotion and management of this sports speciality.

Methodology

This research was based on performing a survey of habits, motivations and preferences. This survey was carried out during the 16th edition of the popular Trotamons Bike Race - Fraga event, in 2019, in the on-line format, using the Kobotoolbox platform, in two languages (Catalan and Spanish). The survey was sent to the 1096 people signed up for that race once the event was finished. The link on the Kobotoolbox platform was available for ten days after the event. During this period, two reminders were sent to the participants. 461 answered questionnaires were obtained, a response rate of 42%.

The survey model used was structured taking into account three dimensions: sociodemographic characteristics (gender, age, education, occupation, habitual place of residence, family situation, number of minor children at home, environmental awareness and sensitivity), sports practice habits (years of practice, sports initiation, sporting experience, federative relationship, physical condition, frequency of training and practice of other sports and specialities), and motivation and preference for practice and participation in events (motivation for practice, participation in events, preferences in route design and importance and satisfaction in services and equipment). The validation of the questionnaire was carried out using expert judgement (consisting of three people) who assessed using a Likert scale (1 totally disagree - 5 totally agree) the lack of ambiguity and the relevance of all the questions included in the initial survey version. There were a total of 22 questions in the final version of the survey.

This study received the approval of the Ethical Committee for Clinical Research (CEIC) of the Sports Administration of Catalonia, as number 09/2019/CEICEGC. All the people who participated in the study did so voluntarily, being informed of and accepting the confidential processing of their responses which is subject to the guarantees of Organic Law 3/2018, of December 5, on the Protection of Personal Data and guarantee of digital rights.

The data obtained were transformed and coded using the SPSS program, version 25.0. The data analysis was based on the application of descriptive statistical analysis according to characteristics and distribution (normality test) of the various variables: frequencies, mean, maximum and minimum values, median, interquartile range (IQR).

Results

Sociodemographic characteristics

Table 1 shows the results for the sociodemographic characteristics of mountain bikers. A predominance of the male gender (94.4%) was observed over the female (5.6%), with 43.4% in the age range from 36 to 45 years, and with a mean age of 43.49 (8.97) years. In turn, a profile was identified of a high educational level (36.4% having been to university), an employee (57.9%) and habitually residing in Catalonia (61.6%). As for the family situation, the most common was that of married or with a partner (79.8%) with a median number of minor children at home of 1.00 [0.00-2.00].

In terms of environmental awareness and sensitivity, more than 67.2% considered that their practice did not produce any impact on the environment. On the other hand, we found that 32.9% believed that mountain biking events did produce some type of impact, these being split into two levels: 25.6% believed that the impact produced was minimal and should not be considered. On the other hand, 7.2% showed the need to consider the impacts that could arise from the practice. Likewise, 27.5% of the practitioners were able to detect during the event various actions to minimise the impact carried out by the Trotamons Bike Race organisation, with waste management as the most highly valued action among practitioners, at 13.2%.

Table 1
Sociodemographic characteristics of mountain bikers.

Variable	N = 461	Total
Gender		
Male (%)	435	94.4
Female (%)	26	5.6
Age		
16-25 (%)	13	2.8
26-35 (%)	61	13.2
36-45 (%)	200	43.4
46-55 (%)	149	32.3
56-65 (%)	34	7.4
> 65 (%)	4	0.9
Age (years). Mean (SD)	461	43.49 (8.97)
Education		
Primary school (%)	58	12.6
Secondary school (%)	91	19.7
Baccalaureate - FP (%)	144	31.2
University undergraduate (%)	118	25.6
Postgraduate studies - masters (%)	44	9.5
Postgraduate studies - PhD (%)	6	1.3
Occupation		
Student (%)	12	2.6
Unemployed (%)	2	0.4
Public employee (%)	84	18.2
Employee (%)	267	57.9

Note. Continuous data are expressed as mean (SD) or median (IQR) depending on their distribution.
SD = standard deviation; IQR = interquartile range. (*) These values were calculated for an *n* = 151.
(**) These values were calculated for an *n* = 122.

Tabla 1 (Continued)
Sociodemographic characteristics of mountain bikers.

Variable	N = 461	Total	
Business owner - self-employed (%)	87	18.9	
Stay-at-home partner (%)	1	0.2	
Retired (%)	7	1.5	
Other (%)	1	0.2	
Place of residence			
Aragon (%)	125	27.1	
Catalonia (%)	284	61.6	
Other autonomous communities (%)	49	10.6	
Other countries (%)	3	0.7	
Family situation			
Single (%)	62	13.4	
Married or with a partner (%)	368	79.8	
Widowed (%)	2	0.4	
Divorced - separated (%)	22	4.8	
Other (%)	7	1.5	
Number of minor children at home			
Less than 1 (%)	187	40.7	
1 (%)	111	24.1	
2 (%)	140	30.4	
More than 2 (%)	22	4.8	
Children under 18 (children). I [IQR]	460	1.00	[0.0-2.0]
Environmental awareness and sensitivity			
Impacts			
Think not (%)	310	67.2	
Think so (low level) (%)	118	25.6	
Think so (to be considered) (%)	33	7.2	
Minimisation of impacts (organisation)*			
Yes (%)	127	27.5	
No (%)	24	5.2	
Minimisation actions detected**			
Waste management (%)	60	13.2	
Organiser information (%)	14	3.1	
Organisation staff (%)	14	3.1	
Refreshments (%)	12	2.6	
Signage (%)	8	1.8	
Trail selection (%)	7	1.5	
Other (%)	7	1.5	

Note. Continuous data are expressed as mean (SD) or median (IQR) depending on their distribution.
SD = standard deviation; IQR = interquartile range. (*) These values were calculated for an *n* = 151.
(**) These values were calculated for an *n* = 122.

Sports practice habits

Table 2 shows the data gathered in the study on the sporting habits of mountain bikers. Among the main results found, the fact that more than 95% of the cyclists surveyed stated that they were regular practitioners of this sporting speciality stood out, with a median experience of 8.00 [5.00-15.00] years of practice, of whom 72.9% said they had been doing it for more than 5 years.

Likewise, and in relation to previous experience in the practice of sports activities, 15.2% of users had changed from road cycling to mountain biking. Thus, in reference to physical activity experiences prior to mountain biking, the majority of users stated that they had done other sports (74.6%). However, 25.4% declared that they started directly in mountain biking.

As for federation membership, a high percentage of membership was observed, 43.6% to be exact, of whom some had more than one federation license; A total of four different federations were found of which the practitioners

who participated in the survey were members. These were: the Royal Spanish Cycling Federation (RFEC), Catalan Cycling Federation (FCC), Spanish Federation of Mountain and Climbing Sports (FEDME) and the International Cycling Union (UCI).

On the other hand, the answers obtained in the physical condition question revealed that 61.2% of the practitioners considered themselves at an intermediate level, with a mean of 2.87 (0.68) on a scale going to 5. In this respect, the practitioners recorded a median of 2 [2-3] weekly training sessions linked to the practice of mountain biking. 49.7% were in the range of 1-2 weekly training sessions while 40.3% were in the range of 3-4 training sessions.

Among the most practised sports and specialities were found road cycling, with the highest representation, at 28%; mountain racing (TR, trail running) in second place, at 14.9%, followed by fitness, swimming and mountaineering/mountain climbing, at 11.1%, 9.9% and 9.8%, respectively.

Table 2
Sporting habits of the practitioners.

Variable	$N = 461$	Total	
Regular practitioner			
Yes (%)	442	95.9	
No (%)	19	4.1	
Time practising			
Less than 1 year (%)	24	5.2	
More than 1 year (%)	437	94.8	
Between 1-3 years (%)	62	13.4	
Between 4-5 years (%)	39	8.5	
More than 5 years (%)	336	72.9	
< 1 year of practice (months). M_e [IQR]	22	7.00	[4.00 - 9.25]
> 1 year of practice (years). M_e [IQR]	439	8.00	[5.00-15.00]
Came to MTB from cycling			
Yes (%)	73	15.8	
No (%)	388	84.2	
Experience in physical activities before mountain biking			
Yes (%)	344	74.6	
No (%)	117	25.4	
Federation member			
Yes (%)	201	43.6	
No (%)	260	56.4	

Note. Continuous data are expressed as mean (SD) or median (IQR) depending on their distribution. SD = standard deviation; IQR = interquartile range. (*) These values were calculated for an $n = 213$. (**) These values were calculated for an $N = 685$.

Table 2 (Continued)
Sporting habits of the practitioners.

Variable	N = 461	Total	
Federation type*			
Royal Spanish Cycling Federation (RFEC) (%)	138	29.9	
Catalan Cycling Federation (FCC) (%)	39	8.5	
Spanish Federation of Mountain Sports and Climbing (FEDME) (%)	18	3.9	
International Cycling Union (UCI) (%)	18	3.9	
Physical condition	461		
Beginner (%)	10	2.2	
Amateur (%)	105	22.8	
Intermediate (%)	282	61.2	
Expert (%)	61	13.2	
Performance (%)	3	0.7	
Physical condition (Likert 1-5 scale). Mean (DT)	461	2.87	(0.68)
MTB training frequency (per week)			
Less than 1 (%)	9	2.0	
1-2 (%)	229	49.7	
3-4 (%)	186	40.3	
5-6 (%)	33	7.2	
7-8 (%)	3	0.6	
More than 8 (%)	1	0.2	
Weekly MTB training sessions. M_e [IQR]	461	2.00	[2.00 - 3.00]
Practice of other sports and specialties**			
Cycling (%)	192	28.0	
Mountain running (%)	102	14.9	
Fitness (%)	76	11.1	
Swimming (%)	68	9.9	
Mountaineering/mountain climbing (%)	67	9.8	
Skiing (%)	57	8.3	
Paddle (%)	41	6.0	
Other (%)	82	12.0	

Note. Continuous data are expressed as mean (SD) or median (IQR) depending on their distribution. SD = standard deviation; IQR = interquartile range. (*) These values were calculated for an *n* = 213. (**) These values were calculated for an *N* = 685.

Motivation and preference for practice and participation in events

For motivation, two questions were taken into account, both valued on a scale of 1 to 5. In the first, a list of statements that justified the love of mountain biking was scored. In the second, the main motivation that had led the practitioner to take up the sporting event were assessed.

In the breakdown of the answers given to both questions, it was found that the motivation for the practice most valued by the practitioners were: the enjoyment of practising the sport, with a score of 4.55 (0.66). In second position, at 4.54 (0.63) was improvement in health and fitness. Finally, in third and fourth position, related to psychological health, were the motivation of disconnection

and the improvement of various levels (psycho-physical-emotional), with values of 4.36 (0.77) and 4.42 (0.71), respectively (Figure 2).

Regarding the motivation for participation (Figure 3), the motivation of enjoyment produced by participating

in a mountain biking event with a 4.43 (0.72) stood out above the rest, followed by the improvement in physical condition that occurs during the competition, with a 4 (1.02). Finally, in third place, was the motivation for personal improvement that the event itself produces.
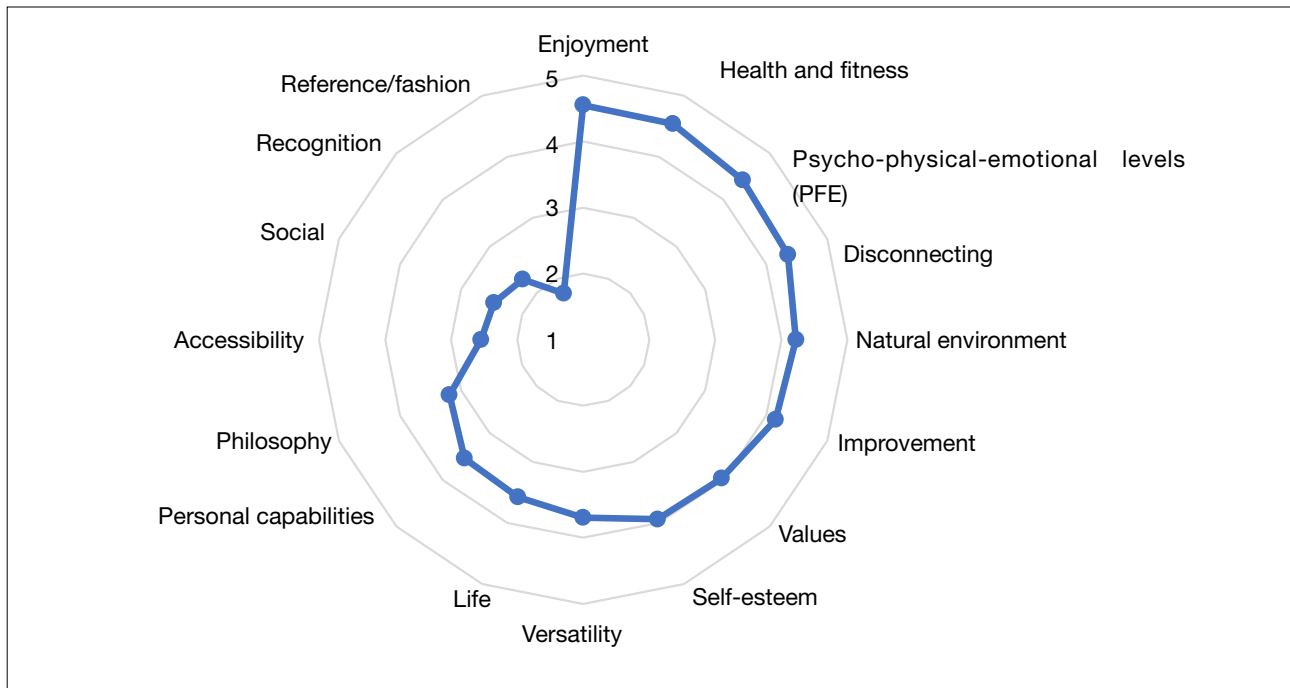
Figure 2
Motivations for the practice (Likert scale 1-5).
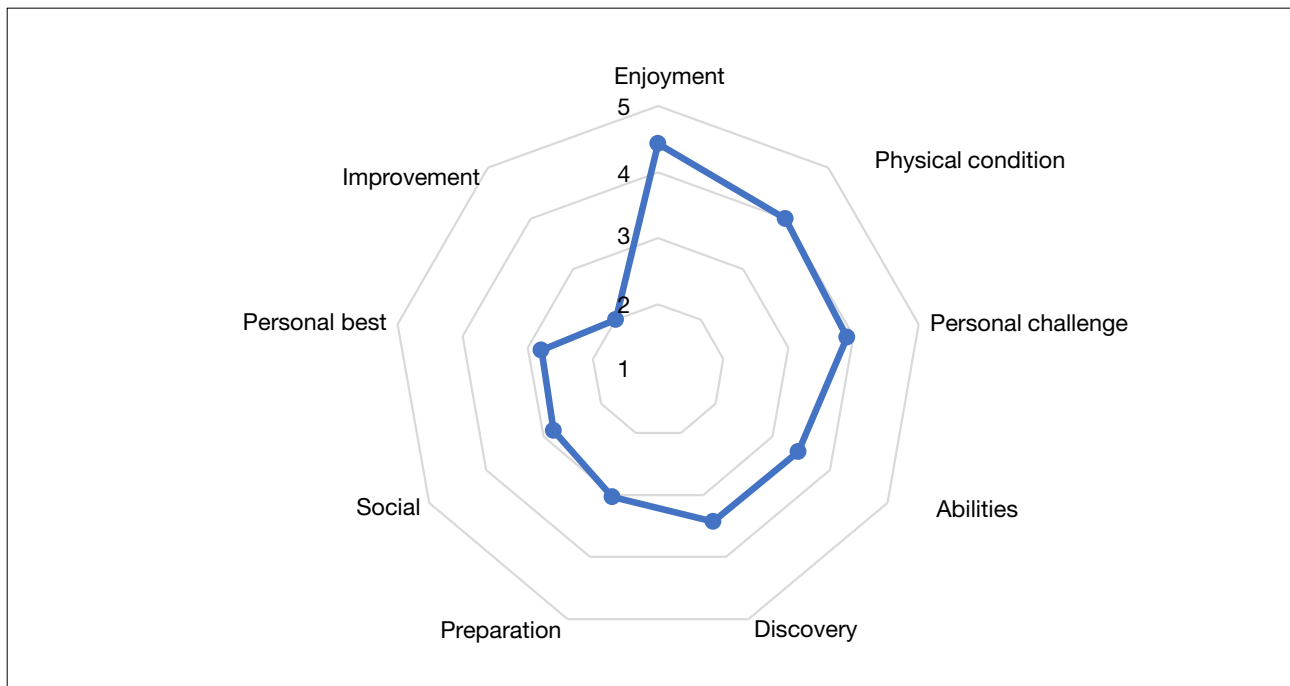
Figure 3
Motivations for participating (Likert scale 1-5).

Regarding the preferences in the design of mountain bike races (Figure 4), there were nine attributes valued by the practitioners on a scale going to 4, with social resources (support staff, care, etc.) as the attributes given the highest level of importance, at 3.59 (0.51), closely followed by the logistics of the event (parking, public transport, etc.), at 3.53 (0.55), and the physical resources of the organisation (arrival, departure, refreshments, etc.), at 3.51 (0.58).
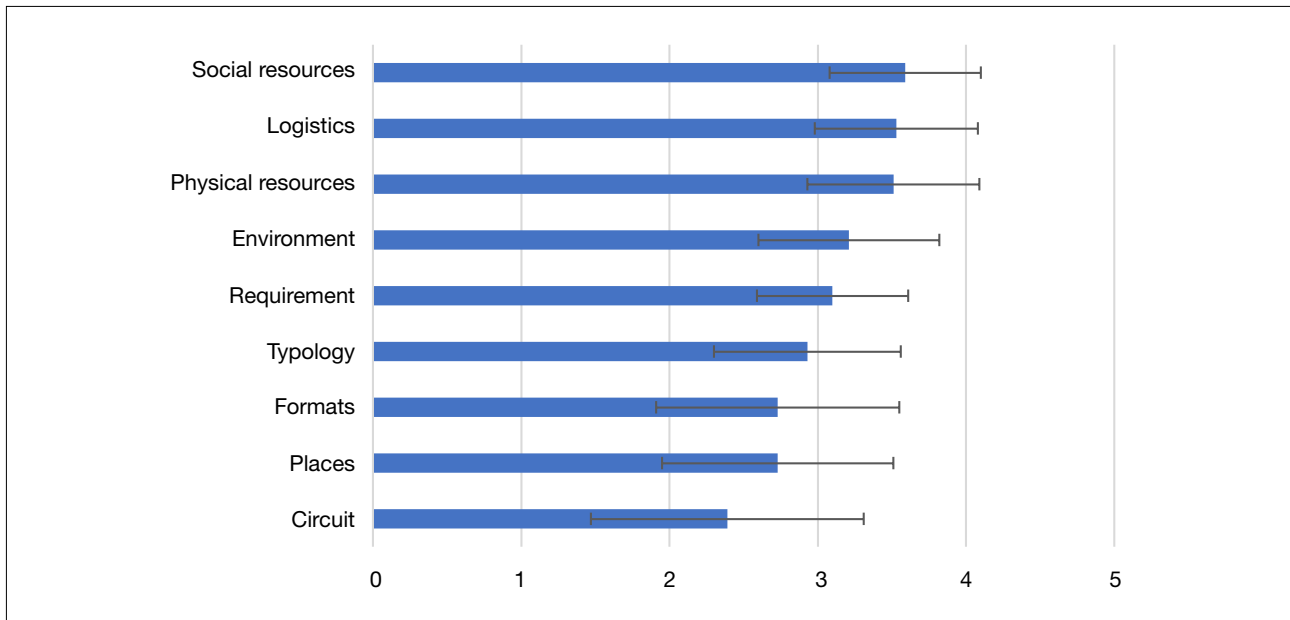
Figure 4
Preferences in the design of MTB races (Likert scale 1-4).

Finally, Figure 5 shows the importance that practitioners gave to the services and equipment in mountain biking events. Attention to the practitioner was found to be the most valued, at 4.52 (0.63), followed by the race route, at 4.37 (0.70).

In third and fourth place were the refreshment stations, at 4.31 (0.80), and the entrances and parking, at 4.28 (0.77).
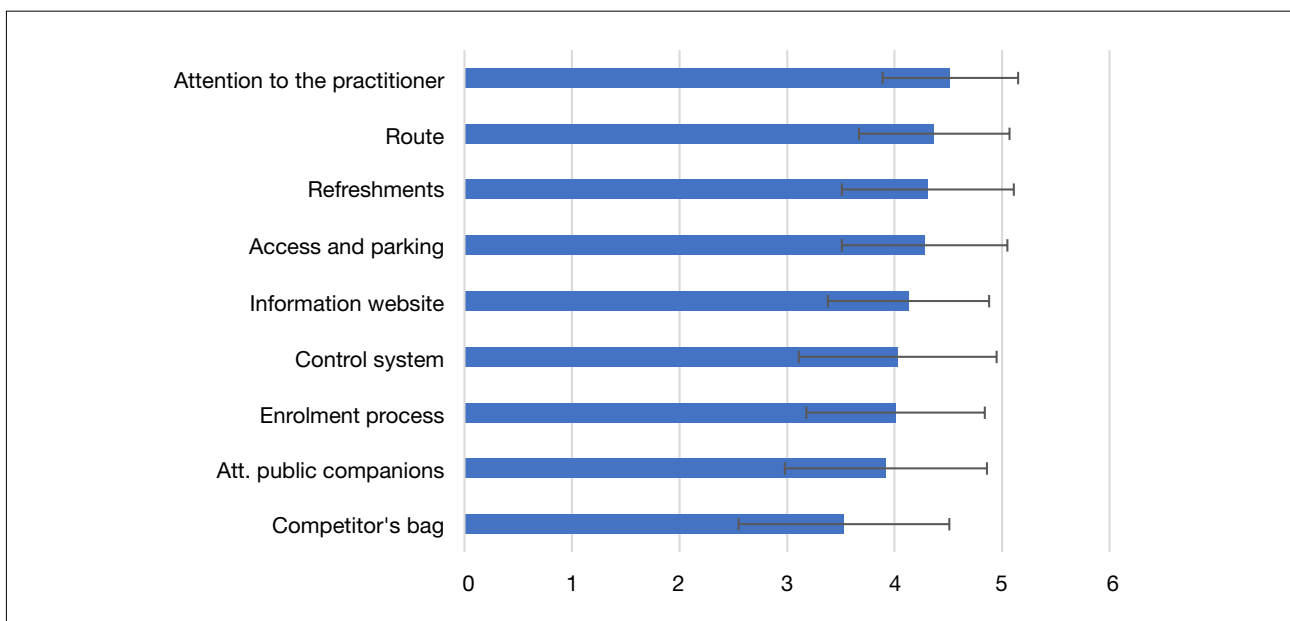
Figure 5
Level of importance of services and equipment in mountain biking events (Likert 1-5 scale).

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Discussion

With regard to sociodemographic characteristics, the results produced by this study, in line with those of previous studies, such as those carried out by Cessford (1995), Rejón-Guardia et al. (2020), Roberts et al. (2018) and Seguí-Urbaneja et al. (2020), showed a great predominance of males over females, with a clear presence of a medium-high educational level. However, as regards the age range, differences were found with respect to the studies by Cessford (1995) and Rejón-Guardia et al. (2020), an aspect that agrees with the studies by Roberts et al. (2018) and Seguí-Urbaneja et al. (2020).

Regarding sporting habits, agreement was observed in the frequency of training (between one and two weekly sessions) with the results obtained by Cessford (1995), Rejón-Guardia et al. (2020) and Seguí-Urbaneja et al. (2020). However, with regard to how long the sport had been practised for (more than 5 years), differences were again found with respect to the studies by Cessford (1995) and Rejón-Guardia et al. (2020), agreeing with the study by Roberts et al. (2018) and Seguí-Urbaneja et al. (2020).

Regarding the level of environmental sensitivity, the difference to the study carried out by Farías-Torbidoni et al. (2021) at a mountain race event, the results found in our study showed the presence of a 20% lower level of sensitivity compared to mountain runners. Taking into account Heer et al. (2003), this could be related to the academic level of the participants surveyed. These data, in our case, were 24.6% below the results found by Farías-Torbidoni et al. (2021).

It is necessary to point out the similarity of the results obtained for the motivations receiving the highest score from the practitioners, both in relation to the practice itself and with the participation in mountain biking events: enjoyment, the improvement in physical condition and in psychological health. These agree with the two main motivations for participation in events found by Kruger et al. (2016). The differences in the motivations found in the results of the studies by Bordelon and Ferreira (2019) and Getz and McConnell (2011) could be justified by the recreational-competitive nature of the Trotamons Bike Race event, that has taken place for many years in the town of Fraga and which has great symbolism among the local population and the surroundings, compared to the events covered by those authors (large MTB events).

Finally, regarding the results obtained for the most valued aspects of the organisation of the Trotamons Bike Race event, it is worth highlighting the highest score achieved by these three items: attention to the runner, design of the route and supplies, with the competitor's bag being the least valued. This result should be taken into account when prioritising actions and resources in the organisation of a mountain biking event, in which a significant part of the economic resources is usually allocated to the preparation of the competitor's bag.

Conclusions and recommendations

The study carried out has made it possible to establish a profile of the mountain biker, with the following characteristics: mostly male (94.4%); with a mean age of 43.49 (8.97) years; university level studies (36.4%); salaried (57.9%); married or with a partner (79.8%); with more than 5 years of practising the sport (72.9%); with low environmental sensitivity (67.2%); taking part in more than one sport and speciality (74.6%); with high federation membership (43.6%); in medium physical condition (61.2%) and with a training frequency of 1-2 sessions per week (49.7%), with the following main motivations for practising this speciality and participating in mountain biking events identified: the enjoyment and the improvement of physical condition and of psychological health.

Based on the results obtained, the need to generate promotional strategies in order to increase the participation of women in this type of sporting event is obvious. On the other hand, taking into account the environmental problems that the practice of mountain biking creates and the history of best practice guides in other sports (mountain running), there are two recommendations one can get from the results obtained in this regard: an increase in actions that promote environmental awareness and sensitivity from the organisations that promote MTB events (giving visibility to the actions they perform to minimise impacts) and a greater integration of the structure these events consist of (improving publicising and communication of the results of the studies of the environmental consequences of this sport).

Finally, the preferences of the practitioners have made it possible to identify the social resources (staff, sportsperson care, etc.), the logistics of the event (entrances, parking, public transport, etc.) and the physical resources (refreshments, assemblies, etc.) as the most valued aspects in the design of a MTB event, in which a greater effort should be made in the management, prioritising these aspects over others such as: that the event is included in a race circuit, that there is a tourist offering associated with the event or the type of MTB event itself (recreational, competitive, charity, etc.), being less important to the practitioners.

Limitations and future prospects

Limitations. Data collection was carried out at a single MTB event (a popular one), so the results cannot be extrapolated to the general population.

Future perspectives. Expand the case studies taking into account the level of the competitive races (beginner, intermediate and performance) to characterise the profile of the mountain biker at the regional level.

Acknowledgements

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Swimmer Dropout Rate:
A Survival Analysis

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Abstract

The length of time that a swimmer frequents a particular sports facility, using the records held by the facilities have often been under-used. We examined various behavioral variables associated with time of attendance until the point of dropout using swimmers' records. 6,749 swimmers were used in this study. The survival analysis focused on the time interval between the moment they became a customer until either the end of the study or the moment when the customer relationship ended (dropout). The Kaplan-Meier estimator was used to gather information as to when dropout would occur; Cox regression and the Logrank test provided statistical comparisons between the groups. The results showed that the swimmers' likelihood of retention beyond 12 months was 53% and the median swimmer's survival time was 14 months. The cohort of customers signing up for more than two sessions per week was likely to stay longer, and the greater the number of visits, the longer the customers were likely to continue (> 40 visits increases the survival probability up to 91.86%). Good sports management practice requires improvements in customer retention; by monitoring the variables of survival rates, we will improve management strategies for sustainability through pre-emptive actions to increase retention.

Introduction

Sports and physical activity are undertaken by all age groups, in various places and with different objectives.

However, every year a large number of people around the world cease to continue attending their sports facility, which contributes to the loss of customers (Elasri Ejjaberi et al., 2015), lowering health levels and reducing financial sustainability. Wade et al. (2020) calculated the dropout rate from physical activity to be around 44.7% after a 12-weeks program. In Portugal, it was found that the average swimmer dropout rate over four seasons was 26.45% (Monteiro et al., 2016). Swimming is the fourth most popular activity in Portugal with 65,499 individuals (IPDJ, 2019).

Retention policies contribute simultaneously to two important management goals: first (i) to promote swimming development, the achievement of results in competitions and the achievement of healthy lifestyles, thereby contributing to customer satisfaction and commitment; second (ii) to enhance the sustainability of the sports organization. Thus, it is clear that retaining customers is a crucial factor for pool owners and sports organizations (Howat & Crilley, 2007) and expansion of sport activities (Tuero del Prado & González Boto, 2015).

The existing literature on swimming identifies swimmer dropout as one of the main issues that coaches and sports managers have to face nowadays (Fraser-Thomas et al., 2008; Monteiro et al., 2017, 2018; Salguero et al., 2003). However, studies on psychosocial factors and processes relating to dropout remain scarce (Monteiro et al., 2017). In the past, surveys were used to understand swimmer behavior, e.g. reasons for joining, maintenance, change and dropout (Marrero et al., 1999). Nowadays, however, center managers have access to swimmer data and behavioral records that have not been used previously to predict swimmer survival time (i.e. time until dropout) and, consequently, to identify methods to encourage survival.

The variety of factors and the multidisciplinarity of research into dropout have lacked a comprehensive approach. Little is known about the variables associated with a) the contractual relationship; b) attendance, such as non-attendance days, and number of visits per week; c) the practice of other activities and customer referrals; and d) gender and age.

These are some reasons why, in this research, we decided to take a different approach, addressing this gap in the literature and adopting a specific methodological approach to produce results of the greatest usefulness to sports managers.

However, this research has a twofold goal, because

it was also designed to investigate and demonstrate the suitability of survival analysis as an instrument to enable sports managers to obtain a more in-depth insight into the factors contributing to swimmers' attendance rates.

Survival analysis, or more generally, time-to-event analysis, refers to a set of methods used to describe the probability of surviving past a specified point in time, or alternatively, the probability that an event of interest has not yet occurred by a point in time (Schober & Vetter, 2018), in our case the giving up of swimming practice.

The central aim of the study is to determine the retention level of swimmers using behavioral variables encountered in sports facilities, by reference to historical customer records.

Methodology

Through the use of 11 variables held on swimmers' records, the objective of this study was two-fold (a) to identify which variables contribute to retention in an aquatic center and (b) to estimate the probability of dropout occurring by a given time.

After a selective procedure, we hypothesized that retention (duration of practice) is influenced by (i) number of visits per week signed up for, (ii) number of enrolment renewals, (iii) month of enrolment, (iv) amount billed, (v) number of visits to the sports facility, (vi) number of average visits per week, (vii) days without attendance, (viii) number of other activities, (ix) number of customer referrals, and finally (x) age, and (xi) gender.

Why should we use survival analysis? Survival analysis is most effective when using data that aquatic center managers have about when events occur: how long did attendance last and what is the probability of dropout occurring when related to a set of variables of a group? The great advantage of using survival analysis lies in the fact that this method allows the prediction of something happening when the changes of that event happening differ systematically across a group. The coefficients in the Cox regression are related to the hazard where a positive coefficient represents a worse prognosis and at negative one a better prognosis. Survival analysis allows us to include information on covariates that would otherwise be omitted. Moreover, the use of the concept of 'censored' (e.g. the customer with an enrolment two months before the observational period ends without dropout), eliminates the bias of the non-survival analysis related to the discarding of information on unobserved events (customers without dropout), which create samples which are non-representative of the population studied.

Participants

We extracted records of 6,749 customers (female *n* = 3,503, mean age = 22.12, SD = 20.89 years; and males *n* = 3,246, mean age = 14.97, SD = 16.78 years) from a swimming pool; data corresponded to the period between June 1, 2014 and October 31, 2017. Data anonymity of the customers was ensured by removing all personal information before recovering data from the software used by the center.

The sports organization that manages the pool provides swimming activities with four objectives: i) learning to swim (beginner to adult), ii) fitness, iii) recreational swimming and iv) training for competitions. The main sports activities performed are swimming (61%), free-swimming (37.5%) and others such as adapted swimming, therapeutic swimming, and pregnancy swimming (1.5%).

An overall description of the analyzed data is given in Table 1.

Table 1
Variable Descriptive Statistics.

Variable		Description	Min	Max	Mean (SD)	
Associated with the contractual relationship	cfreq	Number of weekly sessions signed up for	1	7	2.07	(1.82)
	nrenewals	Number of contract renewals	0	4	1.03	(1.06)
	imonth	Enrolment month	1	12	7.25	(3.17)
	tbilled	Total amount billed during the enrolment	0	1.293	161.77	(158.56)
Associated with the attendance behavior	nentries	Number of visits to the sports facility during enrolment	1	323	29.82	(35.39)
	maccess	Average weekly visits	0.01	3.94	0.60	(0.42)
	dayswfreq	Days without attendance before dropout until October 31, 2017	0	1.073	48.72	(73.42)
Other activities and references	nactivities	Number of activities other than swimming performed by the participant	1	3	1.07	(0.27)
	cref	Number of customer referrals	1	5	0.30	(0.55)
Socio-demographic	age	Age of the participants in years	0	88	18.65	(19.29)
	gender	Gender (0-female, 1-male)	0	1	0.42	(0.48)
Outcomes	months	Customer enrolment time in months	0	47	13.30	(10.91)
	dropout	Indicative of customers' commitment (0 = active, 1 = inactive)	0	1	0.57	(0.49)

Source: own elaboration.

Procedure and Statistical Analysis

The variables extracted from the software correspond to the time interval between becoming a customer until either the end of observation (31 October 2017) or the end of the customer relationship (dropout). The survival time in the dataset is represented by the number of months a user was enrolled at the swimming pool center, thus giving the timespan of the sports practice.

Data processing was conducted using Python (Continuum Analytics, 2016), Pandas (McKinney, 2010) and NumPy (Walt et al., 2011).

The Kaplan-Meier estimator was used to gather information about the dropout event and to estimate survival (Efron, 1988), based on the survival probabilities

and corresponding to the time in which the events were observed (Bland & Altman, 1998).

Results

The probability of swimmer survival time in the first 12 months of practice is shown in Table 2 (column $p_i -$ likelihood probability) and the median survival time was 14 months. The likelihood of swimmers continuing with the sport beyond six months was 73.5%, which represents a risk of withdrawal of 26.5%, and an estimated survival time of 17 months. Swimmers' likelihood of retention beyond 12 months was 53.0 %, representing a higher risk of withdrawal (47%) with an estimated survival of 22 months after enrolment.

Table 2
Survival time probabilities during the first 12 months of attendance.

Event Month	Removed	Dropout	Censored	Risk of Dropout	p_i	Estimated survival (months)
0	5	5	0	6747	.999	14
1	127	52	75	6742	.992	14
2	758	241	517*	6615	.955	13
3	439	433	6	5857	.885	15
4	372	340	32	5418	.829	16
5	346	299	47	5046	.780	17
6	319	274	45	4700	.735	17
7	406	356	50	4381	.675	20
8	268	198	70	3975	.641	20
9	240	183	57	3707	.610	21
10	294	230	64	3467	.569	22
11	206	149	57	3173	.542	22
12	103	71	32	2967	.530	22

Note. Removed – the sum of customers with dropout and that are censored; Censored – the event did not occur during the period of this data collection; Risk of Dropout – number of customers at risk of dropout; pi – survival probability; Estimated Survival - months to survive in the sports facility.
*Corresponds to customers with two months of enrolment without the event of dropout during the time period corresponding to study (between June 1, 2014, and October 31, 2017), for example, customers enrolled in September 2017.
Source: own elaboration.

The number of enrolment renewals affected the survival rate of the swimmers, such that for each renewal the dropout is reduced by 84% (see Table 3 - hazard ratio = 0.16, $p < .01$).

Table 3
Results of the multivariate Cox's regression.

Variable	Regression Coefficient	Hazard ratio	p
Age	0.01**	1.01	<.01
Gender	-0.04	0.96	.26
Dayswfreq	0.00	1.00	<.01
Tbilled	0.00	1.00	<.01
Maccess	0.60**	1.82	<.01
Nactivities	-0.04	0.96	.61
Nentries	-0.03*	0.98	<.01
Cfreq	-0.09*	0.92	<.01
Nrenewals	-1.84*	0.16	<.01
Nreferences	-0.03	0.97	.33
Imonth	-0.15*	0.86	<.01

Note. Impact of the variables on the survival time of the swimmers. *represent an increase in the survival time with $p < .005$ and **a decrease in the survival time with p .005.
Source: own elaboration.

The interpretation is as follows: the hazard ratio is obtained from the exponential of the regression coefficient and gives the effect size of the predictors.

Cox's regression was used to determine the impact of additional covariates on the survival time (Bewick et al., 2004), by analyzing customer behavior in the sports facility. A hazard ratio of 1 represents a null effect on survival time. The negative values in Cox's Regression Coefficient represent an increase in sports practice. The proportional hazard assumptions weren't tested, considering the hazard ratio as an average effect over the observation period (Stensrud & Hernán, 2020). The logrank was applied to the variables that impact the survival time, transformed into categories using quartiles to provide a statistical comparison of groups, where the exception was gender provide additional Socio-demographic analysis. The survival analysis was conducted using the package Lifelines (Davidson-Pilon et al., 2017). The period of the year, namely the enrolment month, was shown to have a positive effect on the survival time of swimmers (hazard ratio = 0.86, $p < .01$), see Table 3.

In contrast, average weekly visits, the number days without attendance and the total amount billed, were found to have a negative effect on the survival time of swimmers' activity, reducing the length of practice (hazard ratio = 1.82, $p < .01$; hazard ratio = 1, p < .01; hazard ratio = 1, $p < .01$), see Table 3.

Lastly, swimmers' age had a negative effect on the length of attendance, i.e., for each age increase, the survival of the swimmers is reduced by 1% (hazard ratio = 1.01, $p < .01$), see Table 3. Regarding the behavioral variables observed in the swimmer's records, associated with the contractual relationship, the number of weeks signed up for leads to a reduction of dropout risk, e.g., for each increase in weeks signed up for, there is a reduction in the dropout probability of 8% (hazard ratio = 0.92, $p < .01$), see Table 4.

Table 4
Results of the logrank test and survival for each group.

Variable	Group	Survival prob. 12 months	Survival median	Logrank test (χ^2)	p-value
age	Less than 5	54.9%	15	204.78	<.01
	5 to 10	64.89%	22		
	10 to 32	43%	10		
	More than 32	48.35%	11		
maccess	Less than 0.3	40.56%	9	294.44	<.01
	0.3 to 0.51	51.41%	13		
	0.51 to 0.80	59.80%	20		
	More than 0.80	62.44	21		
nentries	Less than 6	12.14%	4	3721.13	<.01
	6 to 17	28.53%	7		
	17 to 40	63.70%	17		
	More than 40	91.86%	39		
cfreq	1	53.77%	15	58.34	<.01
	2	48.34%	11		
	More than 2	62.83%	21		
nrenewals	0	1,90%	5	6264.73	<.01
	1	69.88%	16		
	2	85.49%	27		
	More than 2	99.91%	inf		
imonth	Quarter 1	51.95%	15	86.33	<.01
	Quarter 2	47.06%	11		
	Quarter 3	57.02%	16		
	Quarter 4	51.28%	13		
gender	Male (1)	54.57%	15	10.69	<.01
	Female (0)	51.47%	13		

Note. inf represents a value not possible to estimate. The enrolment months were grouped into quarter categories: Quarter 1 corresponds to month 1, 2 and 3: Quarter 2 months 4, 5 and 6; Quarter 3 months 7, 8 and 9 and Quarter 4 months 10, 11 and 12.
Source: own elaboration.

The group of swimmers signed up for more than two visits per week had a probability of survival of 12 months of 62.83% (cfreq), higher than the groups of swimmers who signed up for only 1 or 2 visits. The logrank test for the groups identifying the number of contracted visits per week was significant $\chi^2 = 58.34$, $p < .01$, indicating that survival is significantly different between one, two, and more than two, contracted visits per week (see Table 4).

There are significant differences between groups ($\chi^2 = 6264.73$, $p < .01$) in relation to contract renewals: when swimmers renew two or more contracts, the survival probability for 12 months is 85.49%, which is greater than the group renewing only once (see Table 4).

There are also significant differences between the groups ($\chi^2 = 86.33$, $p < .01$), in terms of the time of enrolment: the group of swimmers enrolling in the third quarter has a survival probability for 12 months of 57.02%, which is greater those the swimmers enrolling in other quarters (see Table 4).

Regarding those behavioral variables observed in the swimmers' records which have a positive effect on the reduction of dropout, for each increase in the number of visits, the dropout probability decreases by 2% (hazard ratio = 0.98, K < .01). The swimmers' group with more than 40 visits has a probability of surviving more than 12 months of 91.86%, which is greater than the other groups. There are significant differences between these groups ($\chi^2 = 3721.13$, $p < .01$), see Table 4.

Generally, the average number of visits per week did not have a positive effect on survival time. However, the results of the logrank test showed that the group of swimmers with a value greater than 0.80 average weekly visits has a 62.44% probability of surviving more than 12 months with a survival median of 21 months. There were significant differences between the groups ($\chi^2 = 294.44$, $p < .01$), see Table 4.

The swimmers' group with ages between 5 and 10 years showed a higher survival probability (64.89%), with a median survival of 22 months.

The logrank test for the groups related to age was significant $\chi^2 = 204.78$, $p < .01$, indicating that survival is significantly different between the age groups (see Table 4). Regarding gender the logrank test was significant $\chi^2 = 10.69$, $p < .01$ with differences between the genders. The summary of the main results is represented in Figure 1.
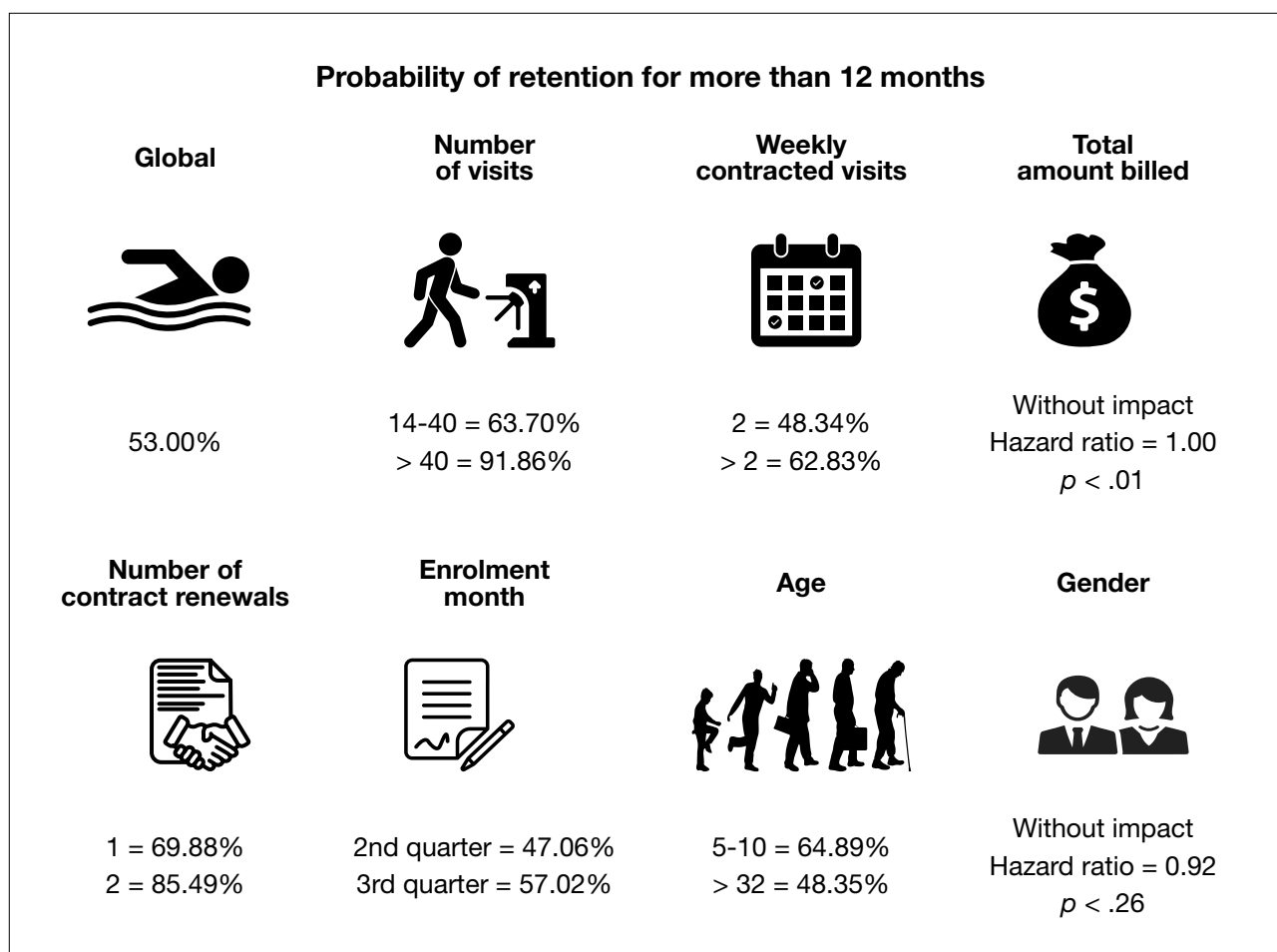

Probability of retention for more than 12 months

Global
53.00%

Number of visits
14-40 = 63.70%
> 40 = 91.86%

Weekly contracted visits
2 = 48.34%
> 2 = 62.83%

Total amount billed
Without impact
Hazard ratio = 1.00
$p < .01$

Number of contract renewals
1 = 69.88%
2 = 85.49%

Enrolment month
2nd quarter = 47.06%
3rd quarter = 57.02%

Age
5-10 = 64.89%
> 32 = 48.35%

Gender
Without impact
Hazard ratio = 0.92
$p < .26$

Figure 1
Study main results.

Discussion

The purpose of the study was (a) to identify which variables contribute most to retention by estimating the probability of dropout occurrence on a time scale and (b) to verify the suitability of survival analysis for this purpose. From the obtained results, we highlight six topics for discussion.

First, the swimmers' likelihood of retention beyond 12 months was 53.0%. The median swimmer's survival time was 14 months, different to the 36 months determined as the average membership duration for members of a fitness center (Zarotis et al., 2017). These results, calculated in different groups, reported differences in the logrank test. The median survival times, according to the different ages, were the following: until 5 years 15 months, between 5-10 years old 22 months; between 10-32 years old 10 months; and > 32 years old 11 months. The gender results also present differences with median survival time for males of 15 months and 13 months for females. Age and gender were also addressed in previous research identifying differences among genders and between age groups (Monteiro et al., 2018).

Considering the swimming pool center's utilitarian goal (of learning to swim from beginner to adult), the duration can be explained by the fact that after this period people have learned to swim, they have achieved their goal, and thus feel more independent and are able to withdraw.

Second, the number of contract renewals, and the time of year, namely the enrolment month: the number of visits signed up for influences the duration of attendance, and the number of contract renewals was confirmed as contributing to higher survival values. Significant differences were detected between each group of swimmers. The group that signed up for more than two visits per week had longer survival rates than the other groups (median survival of 21 months and a survival probability of 62.83%).

The number of visits signed up for had a positive effect on survival time, which can be explained by two aspects: first, the individual's intention to take regular exercise, related to the perceived benefits of regular practice of physical activity (in this case, the practice of swimming); second, higher levels of satisfaction of fundamental needs lead to greater desires to continue (Deci & Ryan, 2000), thereby giving rise to higher levels of retention.

Third, the number of renewed contracts affected the swimmers' survival time, so that, for each renewed contract, dropout was reduced by 84%. This suggests that when people perceive they are developing a skill in relation to an activity, they are more likely to develop an increased motivation to continue to develop that skill, in this case, swimming.

Fourth, the time of year in which an individual enrolled (enrollment month) contributed to an increase in duration of the swimmer's survival in the sport. The swimmers' group enrolling in the third quarter had a survival probability higher than those swimmers enrolling in other quarters. A likely explanation for this result may be that the sports season and the school year start at the end of the third trimester, being the period in which swimmers enroll for the sports season, and swimming classes are formed. This is also related to the satisfaction of fundamental need as individuals seek to satisfy their perceived relatedness to others in the community or, in this case, to individuals within swimming groups.

Fifth, the number of visits increase the survival rate of swimmers. Additionally, the results of the logrank test corroborate these results, suggesting significant differences between each group. The swimmers' group with more than 40 visits to the swimming pool had an increased survival probability (> 40 entries goes up to 91.86% for more than 12 months) than the swimmers' groups with fewer visits. Similar to previous studies, the number of visits has been related to a lower probability of withdrawal (Emeterio et al., 2019, 2016; Ferrand et al., 2010).

Although the average number of weekly visits did not have a positive effect on survival time, the logrank results show significant differences between the groups, showing that increasing average visits results in higher survival time. The swimmers' group with average weekly visits of more than 0.8 had an increased survival probability than the other groups. This result corroborates previous studies which showed that the number of weekly visits is associated with greater commitment in clubs and a lower probability of dropout (Emeterio et al., 2019; Ferrand et al., 2010). In addition, Ferrand et al. (2010) found that weekly attendance rates positively affect customer's intentions towards repurchase. The result can be better understood when there exist a) a higher weekly frequency and number of visits, b) improved learning of swimming techniques, thereby improving the perception of their skills, and increasing their motivation to continue.

Sixth, the results support the hypothesis that age influences the duration of practice. Previous literature has also identified age as a significant predictor for retention (Emeterio et al., 2016; Ferrand et al., 2010), which is confirmed with the lower survival in the two older groups used to calculate the logrank test. Emeterio et al. (2016) identified age (older or younger than 33 years) as having a significant effect on sports dropout. Adult swimmers, unlike younger swimmers, seem to have higher dropout rates: 36.51%, compared to the average of 26.45% (Monteiro et al., 2016). It is likely that the age variable in swimmers' records may have a positive

effect on dropout. We did not find significant predictive value of 'gender' in line with other studies (Emeterio et al., 2016, 2019).

Implications for sports managers

Considering there is an excessive amount of information, how can these results help managers of aquatic centers?

Survival analysis has advantages in determining the timing and variables related to dropout. The median survival time provides a crucial indicator to sports managers, identifying the exact time in which to take action, such as by defining an incentive plan whose implementation will reduce dropout rates.

The results show that the median swimmer's survival time was 14 months. To prevent dropout, when swimmers exceed the first few months, action needs to be taken to counteract negative outcomes, like impaired performance and dropout. This monitoring should be conducted with short surveys on key individual and social aspects of training sessions. In addition, strategies to avoid dropping out should include the development of tools (e.g., coach training, prevention programs on swimmer dropout management) to encourage customers' well-being and satisfaction through the evidence of individual skill gains. These actions should be developed according to some cohorts, targeting actions to early-stage swimmers and for those with more than 32 years old with a median survival time of 11 months, where the age group between 5-10 years old presents longer survival times (median of 22 months). Although the result among genders presents similar results regarding median survival times (13 and 15 months for females and males, respectively). This aspect could represent a similar approach in the timings to target preventive retention actions. This could limit the decrease in the risk of performance decline and sport dropout.

The results show that the number of contract renewals affects the survival time of swimmers, i.e., when swimmers renew more than two contracts, they have an increased survival probability of 85.49%, which is higher than the swimmers' group renewing only once. Sports managers can develop strategies to ensure membership renewal using sales techniques to guide swimmers towards goals and showcase acquired skills, thereby improving swimmers' motivation to continue through contract renewal (e.g., authorized filming before and after learning classes).

The moment at which an individual enrolls (in the third trimester) also contributes to the increased duration of the swimmer's survival in sports. This result suggests that sports managers should create temporary campaigns that include stimuli and benefits of various types (price, discounts, special offers) to promote swimmer enrolment during the third quarter of the year.

Our results also show that the number of visits contributes to increasing the survival rate of swimmers. The group of swimmers with more than 40 visits had a higher survival probability. This indicator has limitations as it can only be observed at the end of the year. Therefore, it is suggested that sports managers should use similar indicators by quarter or semester. Swimmers with indicators of a reduced score, increasing the likelihood of withdrawal, should be closely monitored. Technical and commercial staff should carry out actions to show off newly acquired skills in customers - to increase motivation with the corresponding effects on survival time gain. Staff and coaching attributes are essential for raising the swimmers' motivation level. These factors should lead to investment in skilled human resources and staff training, as increased pool access leads to retention of swimmers.

These results could assist in the design of different lines of action to reduce dropout with reference to different groups. Sports managers may be recommended to use this indicator as a criterion by which to divide people into distinct swimmer groups, with appropriate price, activity and interaction profiles to increase motivation, with appropriate timing for increasing the number of visits, which have been seen to be so critical to longer survival time.

Results confirmed that there was shorter survival in the two older groups used to calculate the logrank test, which identified significant differences between groups. Sports managers are encouraged to use the traditional age targeting criteria, to build swimmer groups by age (and expected benefits) incorporation appropriate exercises during lessons to achieve these benefits, increasing motivation, which in turn has effects on survival time. The oldest swimmer cohort segment should require more monitoring and additional actions to increase motivation and reduce the risk of withdrawal. Examples include providing the customers with an appropriate level of choice, explaining the rationale behind decisions, giving them opportunities to take the initiative, and allowing them to work independently to gain the benefits associated with their individual goals. In turn, sports managers should share this information with coaches, and support coaches' efforts to increase swimmer motivation.

However, our study had several limitations mainly related to the availability of swimmer data and behavioral records in the aquatic center where the data was collected. This aspect limited our analysis and did not allowed further developments using others cohort groups, representing overall trends in the cox regression and complemented with the logrank tests that allowed to deepen the survival

analysis within the analyzed groups. The sport managers should consider the importance of registering the dropout reason as an important factor to analyze deeply this thematic, allowing to improve the identification and creation of preventive actions to reduce dropout, which was not possible in the available data.

In summary, sports managers should consider the significant predictors of the number of contract renewals, enrolment month, number of weeks contracted, the total number of visits, average weekly visits and age as variables to inform their decisions. By doing so, they can draw up policies and plans of action designed to reward swimmers, with beneficial results.

Conclusions

Our investigation allowed us to draw four main conclusions:

1. The number of contract renewals, and the time of year, namely the enrolment month: the number of visits signed up for influences the duration of attendance, and the number of contract renewals was confirmed as contributing to higher survival values. Significant differences were detected between each group of swimmers.

2. The number of visits increases the survival rate of swimmers. Additionally, the results of the logrank test corroborate these results, suggesting significant differences between each group.

3. The number of renewed contracts affected the swimmers' survival time, so that, for each renewed contract, dropout was reduced by 84%.

4. The average number of weekly visits did not have a positive effect on survival time.

The logrank test allowed us to refine these conclusions giving insights into different groups created for each variable. The risks of dropout in different groups are different, and the timings as to when dropout is likely to occur give sports managers an indication of where to target their actions to improve retention.

The analysis of existing data provides full information for the sport managers to develop actions to reduce dropout. This allows identifying risk cohorts that should be targeted to increase aquatic centers sustainability and simultaneously contribute to longer periods developing physical activity.

Disclosure statement

No potential conflict of interest was reported by the authors.

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SPORT MANAGEMENT, ACTIVE LEISURE AND TOURISM

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EDUCACIÓN FÍSICA Y DEPORTES

Enhancing physical activity in the classroom with active breaks: a mixed methods study

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Abstract

Educators who integrate physical activity (PA) into the classroom stimulate their students and create an engaging environment. The objective of this study was to verify the result of an active methodology programme based on activity breaks to demonstrate: a) the effect of the strategies proposed by the teacher, b) the characteristics of the physical exercises proposed and c) the responses produced in the students during the period of physical activity. A tutor-teacher (6th year of Primary Education) from an educational centre in the Murcia region and a total of 26 students between 11 and 13 years old (M = 11.95; SD = 0.63) took part. The programme was administered for 12 weeks using various procedures during school hours (12 sessions/week). The mixed methods approach allowed combining the quantitative analysis of the implementation of the active break, with an assessment check list and qualitative analysis of the result of the interactive behaviours that appeared, using systematic observational methodology (OM). The results showed that the active break involved the students intensively through a combination of motor skills, postural variations and varied interrelationships. At the same time, it was found that the teacher applied the strategies to promote physical activity more frequently in the classroom when they were: an interruption of the class, movement as social interaction, a proposal with a concrete structure, active participation and cooling down. It was concluded that the activity break programme may be suitable to increase motor participation, as well as the social and cognitive interaction of students during class.

Keywords: active methods, activity breaks, teaching strategies.

Introduction

Childhood obesity has grown exponentially in recent years, which has led to a state of alert in the educational systems of various countries. In this regard, a sedentary lifestyle has become a key factor in the development of childhood obesity (Blanco et al., 2020), putting the health of young people at risk due to its links with negative consequences such as hypertension, hypercholesterolaemia and bone diseases (Orsi et al., 2011). Faced with this situation, the World Health Organization (WHO, 2016), in its report "Ending childhood obesity", focuses attention on schools, the family environment and other socialising and educational environments as being responsible for guiding children and adolescents towards the establishment of a healthy diet and the regular practice of physical activity that lets young people acquire healthy lifestyle habits. In addition, the recommendations established by the WHO (2016) indicate that the age group from 5 to 17 years old should do a minimum of 60 minutes of physical activity every day at a moderate/vigorous intensity and reduce the time they spend using screens.

Thus, numerous investigations suggest the promotion of interventions in schools to combat childhood obesity (Sánchez-López et al., 2019). Healthy habits promoted by physical activities in the classroom can contribute to: a) reducing the risk of diseases (Timmons et al., 2012), b) improving emotional health (Poitras et al., 2016) and c) enhancing learning motivation (Chacón-Cuberos et al., 2020). Along these lines, various empirical studies have analysed the effect of applying various strategies in educational centres to increase physical activity during school hours and to reduce the time students spend seated, such as physical activity programs (Ordóñez et al., 2019), active transport (Sanz Arazuri et al., 2017), active recreation (Méndez-Giménez and Pallasá-Manteca, 2018) and active breaks (Muñoz-Parreño et al., 2020).

Due to the mandatory nature of the current Spanish educational system and the persistence of traditional methodologies in primary and secondary education, it is reasonable to think that children and adolescents dedicate a large part of their time to static learning. However, schools could play a fundamental role in promoting physical activity (Langford et al., 2015; Méndez-Giménez and Pallasá-Manteca, 2018), not only through the subject of Physical Education, but also through the use of other interdisciplinary physical and sports activities that allow their positive effects to affect the entire school population (Ordóñez et al., 2019). Along these lines, the study by Hernández et al. (2010) showed that the physical involvement of students during the school day is very low, their inactivity even exceeded 90% of their time, with most time spent in sedentary school activity. Faced with this situation, various authors (Dyrstad et al., 2018) request organisational changes in educational centres that favour the incorporation of physical activity into the school day, due to the numerous cognitive, academic, and physical-health and behavioural benefits it provides to young people (Masini et al., 2020). It seems that the primary education period is a key one for developing active behaviour patterns in children and for promoting the acquisition of healthy lifestyle habits that contribute to reducing overweight and obesity, factors that are closely related to the maintenance of sporting habits when older (Ordóñez et al., 2019; Vaquero-Solís et al., 2020).

One of the most used strategies in recent years to reduce children and adolescent's sedentary lifestyle are classroom-based physical activity (Watson et al., 2017a), which can be carried out both inside and outside the classroom. Watson et al. (2017a; 2017b) distinguish three ways to incorporate physical activity into the classroom: a) active breaks, defined as short periods of time, between 5 and 15 minutes, in which physical activity is incorporated at a moderate to vigorous intensity, during a class, without the need for special spaces, material or personnel (Masini et al., 2020); b) Curriculum-focused active breaks, short periods of physical activity that include curricular content (Schmidt et al., 2016), and c) Physically active lessons, in which physical activity is integrated into education other than physical education (Riley et al., 2015).

Scientific evidence shows the benefits of incorporating active breaks in the classroom to increase levels of physical activity in students, both during the school day and after school (Muñoz-Parreño et al., 2020), which can reach 50% of the recommendations established by the WHO (Fairclough et al., 2012) and higher levels of physical fitness (Ridgers et al., 2007). Its positive effects are also seen in other variables such as attention span, concentration, executive functions and behaviour towards the task (De Greef et al., 2018; Masini et al., 2020; Méndez-Giménez, 2020; Watson et al., 2017b).

However, despite the fact that, in recent years, the importance of observation in the educational field has become greater for PE (Valero-Valenzuela et al., 2020) as well as for the rest of the subjects (Camerino et al., 2019; Prat et al., 2019) and teacher communication (Castañer et al., 2010), no study has yet used the observational methodology to find exactly what happens when physical activity is included in the classroom, that is, what it is and how it is done during the course of the classes.
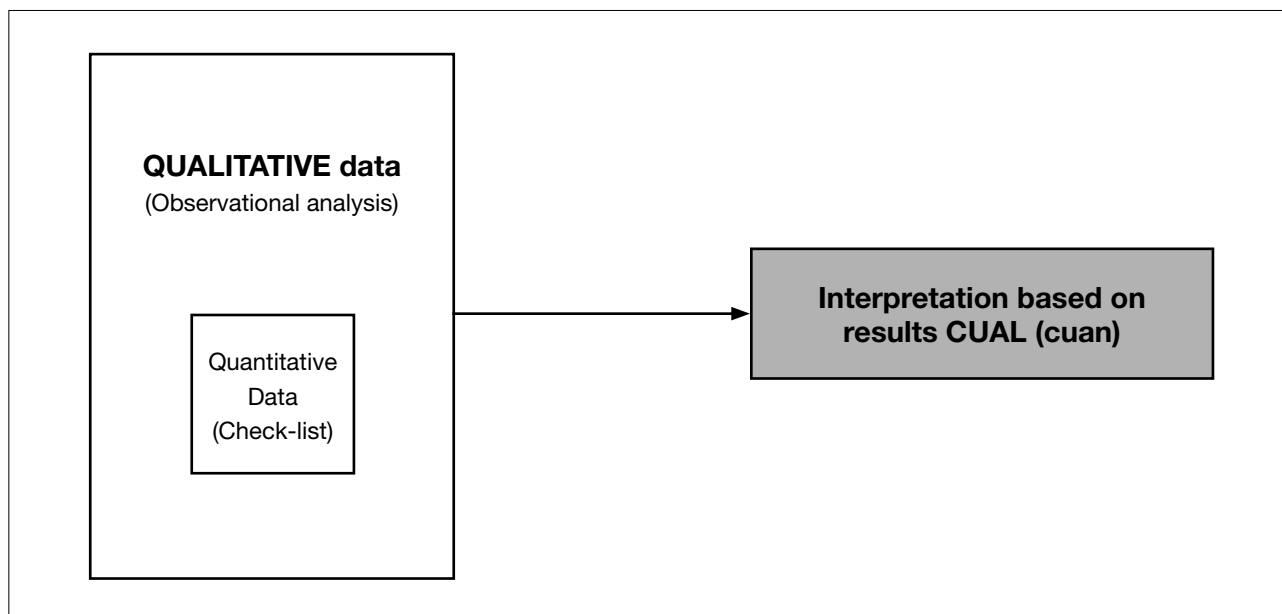
Figure 1
Embedded design dominance (adapted from Creswell and Plano Clark, 2007).

The main objective of the study was to apply an innovative intraclass active breaks programme to find out and assess how the teacher implements it and how close they come to the plan, the characteristics of the proposed activities and the responses that these generate in the students during the proposed period of physical activity.

Methodology

Design

This research was carried out using a mixed methods approach to achieve a greater global understanding of the implementation of an educational and teaching programme (Camerino et al., 2012; Castañer et al., 2013) based on active breaks. Therefore, it was a descriptive, inferential, cross-sectional study using a mixed methodology that was developed using a nomothetic observational design (Anguera et al., 2011), multidimensional (N/S/M) idiographic and with monitoring: a) idiographic, when observing teacher interventions and student interaction in all sessions; b) monitoring, by taking into account the evolution of the teacher's and the students' responses throughout the programme, and c) multidimensional, by wanting to analyse various relevant factors reflected in a multiplicity of criteria in the observation instrument. The prevalence of observational data derived from the video recording and analysis of all the sessions configured an embedded model of pervasiveness in

the management of results (Figure 1), whose purpose is to work with a dominant type of data, in this case qualitative (observational analysis), while looking for other data, as secondary support, in this case quantitative (an assessment check list), which play a complementary role and are subordinate to the former (Castañer et al., 2013). In addition, these authors indicate that these are the most appropriate when conducting complex longitudinal studies, the main characteristics of this research.

Participants

This research was carried out in a primary education centre in the north-east of the Murcia region (Spain). The sample was selected for convenience and accessibility, using entire primary education classes, which consisted of:

(1) Teachers: teacher-tutor (with more than 10 years of experience as a teacher) of a 6th year of primary school who taught various subjects (Mathematics, Social Sciences, Natural Sciences, Applied Knowledge and Spanish Language) and implemented an active breaks programme. The content prepared by the teacher in each of the areas, within the curriculum of the Spanish educational system, were included in the current Spanish educational system (LOMCE, 2013).

(2) Students: the sample consisted of a total of 26 participants aged between 11 and 13 years (M = 11.73; SD = 1.73), who presented a medium-low socio-economic level. None of the students had previous experience with active breaks.

Instruments

To corroborate the effects of the implementation of a methodology in the educational field, Hastie and Casey (2014) establish that one of the key elements that the research group must provide is the validation of the methodology or strategy to be implemented in the study. For this research, this was done by means of an *ad hoc* checklist for the active breaks of the filmed sessions.

(1) Instrument to assess the active breaks (IEDA): the check list was created from the guidelines given by Muñoz-Parreño (2020) on the elements that the active breaks should contain to assess the teaching strategies based on the active breaks. It consists of eight items, which were completed by binary (Yes-No) responses, depending on whether or not the strategies under observation were applied during the PA integration period in the classroom (5'-10'). The *ad hoc* checklist consisted of the following items: 1) class interruption (CI), 2) movement (MOV), 3) academic content (AC), 4) social interaction (SI), 5) session structure (SE), 6) motivation (MO), 7) participation/activation (PA), and 8) cooling down (CD).

(2) Instruction-oriented active breaks observation instrument (SODAE): this instrument was created to record the behaviour and generate behaviour patterns of the teachers and students in the active break implementation sessions in the classroom. The instrument consisted of an observation system consisting of six criteria, the first three adapted from the OSMOSTI observation instrument (Observational System of Motor Skills, Space, Time and Interaction) (Castañer et al., 2020) and the other three following the proposals of Muñoz-Parreño (2020). The criteria are related to the proposal and structuring of the active breaks. The teacher role covers the criteria: (1) motor skills, (2) social interaction, and (3) use of space. A criterion related to the performance of the students: (4) student participation, and two criteria related to the characteristics of the active breaks: (5) academic content and (6) cognitive resolution. All of this instrument's criteria fulfilled the criteria of completeness and mutual exclusivity of any observation system. A total of 21 categories were included (Table 1).

Table 1

Observation system for active breaks in teaching, SODAE, adapted from the OSMOSTI system (Observational System of Motor Skills, Space, Time and Interaction) *(Castañer et al., 2020).*

Criterion	Category		Description
MOTOR SKILLS (ME)	Locomotion	LOC	Locomotion actions (eg trips)
	Stability	STB	Actions without displacement (e.g. balancing, jumping, turns)
	Manipulation	MAN	Manipulative actions (with objects or persons)
	Combination	COM	Combination of the above motor skills
	No motor involvement	NMI	There is no motor component
SOCIAL INTERACTION (SI)	Great group	GG	Relating in a large group
	Small groups	SG	Relate in smaill groups
	In pairs	IP	Relate in pairs
	No social interaction	NSI	There is no relationship with others
USE OF SPACE (US)	Spatial direction	CSD	Change in spatial direction
	Spatial level	CSL	Change in the spatial level
	Same space	MSS	Maintain the same space
	Combination of space	CVP	Combination of variations in body posture/gestures and spatial direction
STUDENT PARTICIPATION (SP)	The whole group	GP	The whole group (great participation)
	High participation	HP	The whole group except 1-4 students (high participation)
	Average participation	AP	The entire group except 5-10 students (average participation)
	Low participation	LP	The whole group except 11 or + students (low participation)
ACADEMIC CONTENT (AC)	Academic content	IAC	Integrated academic content
	No academic content	NAC	There is no integration of academic content
RESOLUTION COGNITIVE (RC)	Resolution cognitive	CRE	Cognitive resolution exists
	No cognitive resolution	NCR	No cognitive resolution

Next, we will lay out the steps prior to the implementation and development of the intervention program.

Previous active break training of the teachers

To implement any type of educational programme, specific professional development of the teachers is needed (Lee and Choi, 2015). Along these lines, Pozo et al. (2018) highlight two aspects that research should have: (1) requirement for expert checking and assessment of the intervention, and (2) continuous and close monitoring of the data in the implementation of longitudinal studies, as well as including *ad hoc* methodological designs. The teaching staff were trained in active breaks, using a two-phase approach:

(1) Initial training: a 5-hour theoretical-practical course on active breaks was given, in which the method for adapting physical exercise to the teaching programme for the various subjects was explained to the teachers and they were provided with global and specific strategies for how to incorporate physical activity into the classroom.

(2) Continuous training: initially, the teacher had to deliver a document describing the approach of three active breaks integrated into sessions that had a link with to any of the educational areas they taught. The principal investigator provided comments and suggestions on their proposal. Subsequently, the main researcher met every week with the teacher in order to learn about the development of the programme and provide feedback to the teacher about which aspects that they carried out correctly and which could be improved. This information was transmitted thanks to the analysis of the recorded sessions, the results of which were reflected and delivered to the teacher in the weekly meetings, through a report.

Procedure and intervention

Permission was obtained from the Ethics Committee of the University of Murcia (ID: 3207/2021). The project was then presented to an educational centre in the Mar Menor region, its management team and teachers were informed about the objectives and their collaboration was requested. Finally, informed consent was obtained from the parents or legal guardians of all study participants, in accordance with the ethical guidelines for consent, confidentiality and anonymity of the responses.

After designing the intervention and providing the teacher with all the necessary training in active breaks in the aforementioned training, the intervention of the active breaks educational program began during the planned 12 weeks, based on an active teaching methodology and following

the same content as the educational centre's teaching programme, as established in the curriculum for each of the subjects in which it was implemented (Mathematics, Social Sciences, Natural Sciences, Applied Knowledge and Spanish Language).

In the development of the sessions, three different active break methods were used:

(1) Tabata routines (Tabata et al., 1996), which consisted of a combination of six exercises performed at maximum intensity (e.g.: squats, table push-ups, etc.), with rest periods (Koch, 2004), following the proposal of Muñoz-Parreño et al. (2020). They were used for five days a week, at least once a day. In this case, they were performed throughout the intervention, following a progression of the training load.

(2) Active videos of physical involvement or Brain Breaks Videos (Hidrus et al., 2020), based on the physical mimicry by the students of audiovisual resources projected on the classroom's digital blackboards (e.g.: dances, movements, etc.). This method was also used for five days a week, at least once a day.

(3) Active break with cognitive involvement related to curricular reinforcement (Abad et al., 2014), following the proposal of Solís-Antúnez (2019) on physical exercises in which the curricular content of various knowledge areas is worked at the same time such as Spanish language, mathematics, social sciences, applied knowledge and natural sciences. They were used for two to three times a week, only once a day.

The application of the programme followed a progression in difficulty and the physical exercise load during the active break, especially those in which the Tabata routines were applied. In the first month, routines were carried out in which they worked for 15" and rested for 15". In the following four weeks, resting time was reduced by 5" while motor involvement was maintained (15"-10"). Finally, during the last four weeks the working time was increased and the resting time was maintained (20"-10").

Analysis of the results

A total of 23 sessions were analysed, with a total duration of 55 minutes per session. Two observers, graduates in Physical Activity and Sports Sciences, were trained by experts in observational methodology, following the guidelines established by Wright and Craig (2011). The interobserver reliability before the beginning of the data analysis for the use of the *ad hoc* checklist was 89.1% and for SODAE, 95% (García-López et al., 2012).

Regarding the processing of the results of the IEDA instrument, a descriptive statistic was chosen, with a calculation of the percentages of each of the strategies

used by the teacher (class interruption, movement, academic content, social interaction, structure, motivation , participation/activation, cooling down, application) in the implementation of the programme and its progression during the 12 weeks from its beginning to its end.

To find the most significant teaching behaviours and the response they triggered in the students throughout the educational programme, a detailed visualisation, analysis and recording of ten sessions, representative of each period and randomly selected, was carried out. The LINCE PLUS program and recording instrument (Soto et al., 2019) was used, the results of which were exported in .txt format for analysis to find temporal patterns (T-patterns), with the THEME v. 6 program. (Magnusson, 2000).

Results

Verification of teaching strategies and student responses (IEDA)

The IEDA results showed the progression of the active break-based teaching strategies used by the teacher throughout the intervention (Table 2). Specifically, they showed the differences between the strategies applied by the teacher in the active breaks for each of the weeks of the study. Table 2 shows some results in which it can be seen that the teacher experienced a progressive improvement in the implementation of the active breaks as the intervention progressed. All of this is reflected in the total strategy application percentage in week 1 (66.7%), week 2 (62.5%), week 3 (75%), week 4 (81.3%), week 5 (79.2 %), week 6 (81.3%), week 8 (91.7%), week 10 (95.8%) and week 12 (100%). In almost all of them a progressive improvement is seen, except in 2 and 5, in which it is reduced, and in 6, which is the same as week 4. In addition, a significant percentage difference is observed between the teaching strategies incorporated in the active breaks of week 1 (66.67%) and week 12 (100%).

The total strategy application percentage, throughout the intervention, was above 60%. And after week 2, the percentages did not drop below 75%, and were even above 90% in weeks 8, 10 and 12. Thus, an increase in the fidelity in the implementation of the active breaks was verified.

The most applied strategies during the active periods in the intervention were social interaction, movement, structure, participation and the cooling down, with 100% implementation in the active breaks analysed. The variables social interaction and motivation, both at 56.5%, and academic content (34.8%) were those that were applied least often, especially at the beginning of the study, an aspect that improved in the final weeks of the programme.

Table 2
IEDA results, showing the percentages of the strategies used by the teacher throughout the programme.

	Session	CI	MOV	AC	SI	SE	MO	PA	CD	Total items	%
	AB 1	Yes	Yes	No	No	Yes	No	Yes	Yes	5	62.5%
	AB 2	Yes	Yes	Yes	No	Yes	No	Yes	Yes	6	75%
Week 1	AB 3	Yes	Yes	No	No	Yes	No	Yes	Yes	5	62.5%
	M Total									5.33	66.7%
	AB 4	Yes	Yes	No	No	Yes	No	Yes	Yes	5	62.5%
Week 2	AB 5	Yes	Yes	No	No	Yes	No	Yes	Yes	5	62.5%
	M Total									5	62.5%
	AB 6	Yes	Yes	No	No	Yes	Yes	Yes	Yes	6	75%
Week 3	AB 7	Yes	Yes	No	No	Yes	No	Yes	Yes	6	75%
	M Total									6	75%

Note. % = percentage; CI = class interruption; MOV = movement; AC = academic content; SI = social interaction; SE = session structure; MO = motivation; PA = participation/activation; CD = cool down; A = application.

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Table 2 (Continued)
IEDA results, showing the percentages of the strategies used by the teacher throughout the programme.

| Session	CI	MOV	AC	SI	SE	MO	PA	CD	Total items	%	%
Week 4	AB 8	Yes	Yes	No	No	Yes	No	Yes	Yes	7	87.5%
	AB 9	Yes	Yes	No	Yes	Yes	No	Yes	Yes	6	75%
	M Total									6.5	81.3%
Week 5	AB 10	Yes	Yes	No	No	Yes	Yes	Yes	Yes	6	75%
	AB 11	Yes	Yes	No	Yes	Yes	No	Yes	Yes	6	75%
	AB 12	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	7	87.5%
	M Total									6.33	79.2%
Week 6	AB 13	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	7	87.5%
	AB 14	Yes	Yes	No	Yes	Yes	No	Yes	Yes	6	75%
	M Total									6.5	81.3%
Week 8	AB 15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	100%
	AB 16	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	7	87.5%
	AB 17	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	7	87.5%
	M Total									7.33	91.7%
Week 10	AB 18	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	100%
	AB 19	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	7	87.5%
	AB 20	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	100%
	M Total									7.67	95.8%
Week 12	AB 21	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	100%
	AB 22	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	100%
	AB 23	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	100%
	M Total									8	100%
	M Total	100%	100%	34.8%	56.5%	100%	56.5%	100%	100%		81%

Note. % = percentage; CI = class interruption; MOV = movement; AC = academic content; SI = social interaction; SE = session structure; MO = motivation; PA = participation/activation; CD = cool down; A = application.

Teaching performance and student response (SODAE)

The analysis of temporal patterns shows that the teacher, during the intervention, followed various sequenced and typical behaviours. In the dendrogram (Figure 3) it can be seen that a combination is proposed in which a stability (SPE) physical exercise is proposed in which there is no social interaction (NSI), there is a change in the spatial level (CEE), works the entire group (WEG), the academic content is not reinforced (NAC), but the cognitive resolution (CR) is reinforced, which is preceded by a rest period in which the students recover for the next metabolic effort (NIM-NSI-MME-WEG-NAC-NCR). After this sequenced behaviour, a physical exercise reappears in which motor skills (CMS) are combined, without NSI, with a combination of postures (CVP), in which WEG, without NAC reinforcement and with CR, which is once again preceded by a period of rest (NIM-NSI-MME-WEG-NAC-NCR). Thus, it can be said that the structure proposed by the teacher to implement the active breaks is repeated consecutively while it lasts (5-10 minutes).
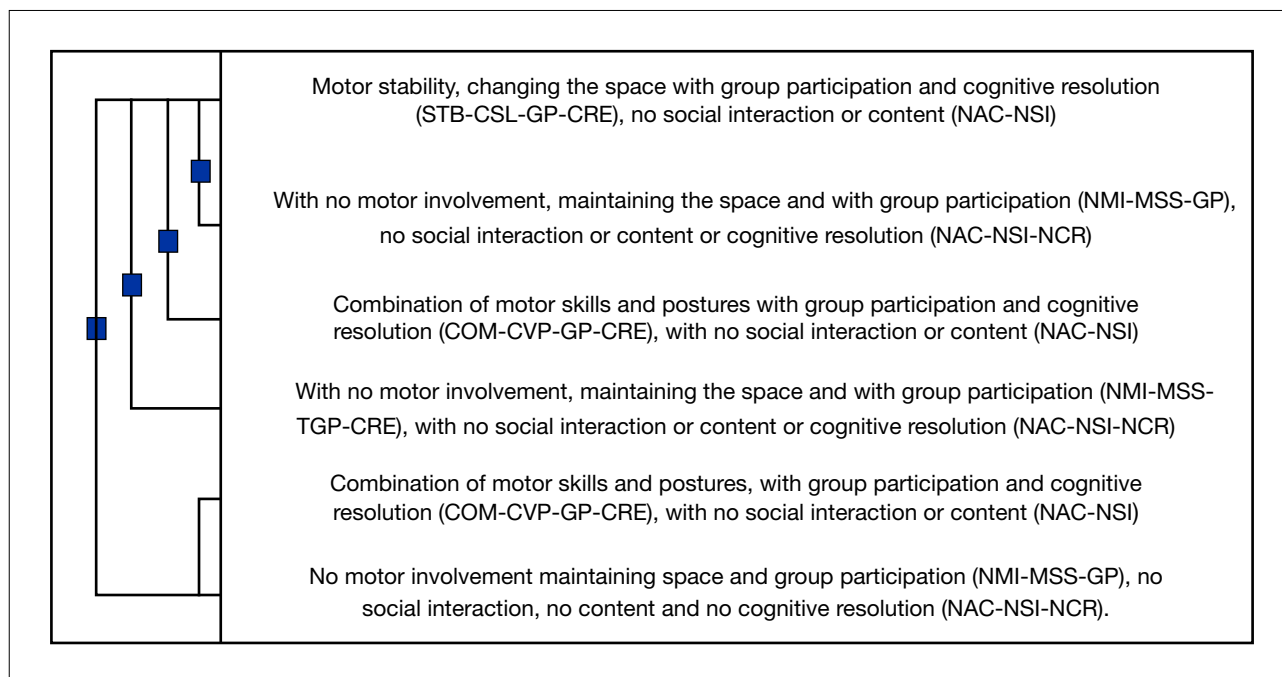
Figure 2
Dendrogram showing the performance of the teacher and the response of the students in the intervention sessions analysed.

Discussion

The general objective of this study was to apply an active break programme in the classroom to find its results in terms of the characteristics of the exercises proposed and the responses produced in the students during the period of physical activity, as well as to assess the degree of fidelity of the implementation.

The results of this study show that the active breaks applied by the teacher have moments of motor resting that occur primarily in the Tabata protocol, in which an active exercise is doe for 20" (e.g. skipping) and rests for 10". When comparing the results with other studies, it should be noted that there are no precedents to date in which active breaks have been evaluated using a mixed methods approach based on the observational methodology (Chacón-Cuberos et al., 2020). During this PA period, the main exercises incorporated by the teacher were combinations of motor skills (e.g. push-ups) and those involving stabilisation (e.g. squats). This type of active break has also been applied in quantitative methodology studies, such as that of Muñoz-Parreño et al. (2020), in which very positive results were obtained in increasing the level of PA, in school and after school, of students at the school.

In addition, the results show that the teacher applied various organisations to promote social interaction, alternating between individual performances and large group collaborations, which allowed the students to be in continuous contact. These results agree with the line of research, such as those of Muñoz-Parreño (2020) and Solís-Antúnez (2019), based on the incorporation of active breaks in primary education through cooperative games and which found positive effects related to the attitude and behaviour of the students in the classroom. Regarding the use of space, the results reflect an alternation between maintaining the space and combining variations in posture (changes in direction and spatial level) throughout the intervention, an aspect that is related to the criterion of social interaction used by the teacher.

On the other hand, this study shows that the academic content was not worked on continuously during the intervention, instead the use of Tabata protocols and active videos predominated. However, the activities proposed by the teacher did involve the students' motor and cognitive centres in their performances. Along these lines, the study by Suárez-Manzano et al. (2018), in which educational interventions based on active breaks were analysed, found that, in 78% of the interventions carried out, students improved their cognitive function of paying attention in class.

Regarding the response of the students in the active breaks, the results show that they participated and were fully involved during the proposed exercises. Therefore, their response was very positive to the incorporation of

PA in the classroom. This evidence allows students to be active and achieve a high percentage of the minimum PA proposed by the WHO (2016), as well as allowing them to acquire healthy lifestyle habits that they can transfer outside the school environment. These results agree with other studies (Fairclough et al., 2012; Muñoz-Parreño et al., 2020; Solís-Antúnez, 2019) that found a high participation by the students and in which the physical activity recorded during the active breaks made it possible to cover 50% of the WHO's recommendations.

Regarding the second objective, the data obtained from the IEDA on the teaching of active breaks were used with the aim of finding the level of fidelity of the implementation, since the interpretation of the results of the studies does not depend solely on verifying whether the intervention was properly implemented, but it is also necessary to find those aspects that were carried out in a more ideal way (Durlak and DuPre, 2008). The results show that the teacher experienced a progression throughout the intervention, beginning with the application of 66.67% of behaviours and ending with 100%. This aspect is very interesting, since it is possible to observe the fidelity achieved by the teacher in the methodological strategies for promoting physical activity in the classroom, after initial training, and the importance of continuous training to ensure a good implementation of strategies during programme development. This can be corroborated by previous studies (Camerino et al., 2019) that highlight continuous training as a key element in the application of innovative methodologies in pedagogical models.

The most valued strategies during these active breaks were class disruption, movement, structure, participation, and cooling down. The variables academic content, social interaction and motivation at the beginning of the intervention were implemented less frequently, an aspect that increased as the intervention progressed. However, there is no scientific evidence with which these results can be compared, since no study to date has evaluated the incorporation of PA in the classroom using a qualitative observational methodology. Most have used quantitative methods, such as accelerometers (Watson et al., 2017b; Watson et al., 2019), which do not allow these types of variables to be observed.

Therefore, this instrument (IEDA) was integrated into the mixed methods approach with the aim of finding which behaviours the teacher used to promote physical activity in the classroom, as well as to carry out a continuous evaluation of the intervention (Hemphill et al., 2015) and verify the viability of the educational programme.

However, the lack of results from previous studies that allows them to be compared has to lead us to be cautious in our conclusions, since there is not yet any scientific evidence in line with this study. For this reason, more studies are needed to investigate the behaviours that active breaks produce in students, taking into account the type of strategy used by the teacher (such as the type of active breaks, their duration and intensity), as well as the consequences for other variables, such as the level of physical activity, measured with highly accurate and reliable instruments (e.g. accelerometers), and quasi-experimental designs with randomised samples.

Conclusions

In line with the objectives proposed for this study, it is concluded that the teacher, during the application of the active breaks programme, mainly used the combination of motor skills and variations in posture through individual and large group organisation. The Tabata protocol, in which a period of active time was preceded by a motor rest, seems to be the intraclass activity method most used by the teacher, which proved to be very effective for the participants.

The results of the IEDA instrument show that the teacher applied, in a progressive and suitable way, the strategies that characterise the active breaks, which favoured the participation and motivation of the students, which are confirmed by the teacher's performance and the students' responses in the intervention sessions analysed with the SODAE system.

These active pauses predispose students to greater attention and lead to cognitive resolution that promotes full group participation and interaction. Finally, regarding the degree of fidelity to the active break strategies, there is a positive progression on the part of the teacher over time, thanks to factors such as initial training, the continuous training process and the experience acquired in the use of the teaching methodology.

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