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Attitudes Towards Doping among Sport Sciences Students

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New Olympic Sports for Tokyo 2020: Karate. Photo: Haifa, Israel - July 11, 2017: The Karate competitions during 20th Maccabiah Games at the Romema Arena.

Abstract

Doping is a concern not only in sport but also in society, given that it is a pressing issue that must be dealt with in the education of future physical activity and sport professionals. The objective of this study was to ascertain the attitudes towards doping of students in the Bachelor's in Physical Activity and Sport Sciences at the University of Valencia. A questionnaire designed specifically for this study whose content was based on similar questionnaires was administered to 347 students of both sexes. The main results include that 94.25% of students are against the possible legalisation of doping, while 5.75% are in favour. When asked in what cases would they take performance-enhancing drugs as athletes, the three main reasons were: 1) to earn large amounts of money; b) to increase their athletic performance and win an Olympic gold medal; and c) to be one of the most successful athletes in history and become world-famous. Each of them was chosen by around one fifth of the sample. Differences were also found in the sex variable. In the majority of situations posited, twice as many men would take performance-enhancing drugs as women. Therefore, and although most of the students are against the legalisation of doping, some of them would take performance-enhancing drugs if they were high-performance athletes.

Keywords: doping, attitudes, health, students, university

Introduction

Doping is a punishable behaviour in sport. For this reason, it is assumed that sport professionals will always take a stand against it. However, occasionally not only do coaches not help to prevent doping (Laure et al., 2001), they may even indirectly promote positive attitudes towards it (Hodge et al., 2013). These attitudes can also be found among other groups as well, such as monitors and sports physicians (Tanner et al., 1995). In the field of education, faculty have to deal with the prevention of doping in adolescence, a population with extremely disturbing figures in the specific case of recreational doping with anabolic steroids (Rachon et al., 2006). Similarly, Strelan and Boeckmann (2006) found that education in moral values and health is a more effective deterrent in the struggle against doping than penalties in competitions. Therefore, practitioners of physical-sport activities should always be educated in a context in which health and ethics are the prime values, which is why it is essential to study educational agents and the role they play in the conception and prevention of doping. In this sense, attitudes towards doping and the training of physical activity professionals are important.

Attitudes towards doping have also been examined by research, with different focal points. Two of them are the attitude towards the potential legalisation of doping in sport and the reasons that would lead an athlete to take performance-enhancing drugs. Studies on attitudes towards a potential legalisation of doping have focused on ascertaining the opinions of different groups, such as the general population (Stamm et al., 2008), athletes (Stamm et al., 2008; Wanjek et al., 2007), coaches (Engelberg & Moston, 2015; Fung, 2006; Mandic et al., 2013) and university students (Awaisu et al., 2015; Saito et al., 2013; Vangrunderbeek & Tolleneer, 2010). The results concur, albeit in different proportions, in showing that the majority disagree with the legalisation of doping in sport. In terms of the reasons that would lead an athlete to take performance-enhancing drugs, the most important one is winning competitions and improving athletic performance (Connor et al., 2013; Mroczkowska, 2011; Scarpino et al., 1990; Striegel et al., 2002). Other studies state that doping behaviour can also influence the perception that the other athletes have of performance-enhancing drugs (Dunn et al., 2012; Morente-Sánchez & Zabala, 2013); a greater ego-, rather than task-orientation towards competing (Sas-Nowosielski & Swiatkowska, 2008), the failure to criticise not following the rules (Whitaker et al., 2012) and being in favour of legalising doping (Kindlundh et al., 1998; Petróczi, 2007).

Thus, two basic research questions can be defined and which have served as referents in this study: What opinion does a particular group within the sphere of sport have towards the potential legalisation of doping? And in what cases would they themselves take performance-enhancing drugs? Given these questions, the purpose of this study was to ascertain the attitudes of future professionals currently in training towards doping, and more specifically students pursuing the Bachelor's in Physical Activity and Sport Sciences (PASS). Therefore, the goal is to ascertain the opinions of this group on a hypothetical legalisation of doping in high-performance sport and the reasons that would lead these students to take performance-enhancing drugs, as well as the associated variables.

Methodology

The study performed is descriptive and quantitative. A questionnaire on attitudes towards doping was administered to a sample of PASS students at the University of Valencia (UV).

Sample

The data were collected in the 2014-15 academic year, when a total of 723 students, 595 males and 128 females, were enrolled in the PASS programme taught in the Faculty of Physical Activity and Sport Sciences at the UV. The final sample of this study was comprised of 347 students, 295 males and 52 females, which corresponds to a maximum margin of error of 3.8%. The mean age of the sample was 21.64 ($SD \pm 4.81$).

Instrument and data-collection procedure

To collect the data, a self-administered, structured written questionnaire developed for this purpose was administered. Content validity was used to establish the internal validity of the questionnaire. This type of validity does not use a statistical criterion, but one based on justifying the content of the questionnaire to ensure that it is adapted to the reality that it seeks to study. Agreement was reached on three aspects: a) the internal logic of the questionnaire through its organisation into the different dimensions studied; b) the conceptual representativeness of these dimensions, taking studies on opinions and attitudes towards doping as the referent in order to produce it (Connor et al., 2013; Mroczkowska, 2011; Whitaker et al., 2012); and c) the subsequent revision of the questionnaire by an expert panel with the participation

of university professors not involved in the project, who approved the final version of the questionnaire.

The data were collected by administering the questionnaire on different days in April 2015 in the theoretical classes held in the Faculty of Physical Activity and Sport at the UV, with the prior authorisation of the centre's administration and the faculty teaching the classes in which it was administered. One of the researchers was present during the data-collection process and when the questionnaires were handed out, completed and returned. Instructions on how to complete the questionnaire properly were given before it was handed out. The students were informed that the data they provided would be used for academic purposes. Filling out the questionnaire was totally voluntary. The participants took some 10 minutes to complete it. Other essential ethical factors related to data collection were also taken into account to guarantee the total anonymity and privacy of the data of the respondents.

Data analysis

Two levels of analysis were conducted in this study. The first one consisted of calculating the statistical indexes, with the goal of describing the variables obtained through distributions of frequencies, percentages, means and standard deviations. The second level focused on analysing the relations among the different variables studied and between them and the sociodemographic variables. The chi-squared statistic was used with the Monte Carlo method to find the degree of significance among the categorical variables. In cases in which study variables and general variables were combined with more than two categories, the contingency coefficient was calculated to analyse and interpret independence or dependence among the variables. Contingency tables were used to describe the relation among categorical variables.

Results

The results are grouped into two subsections: opinion on the hypothetical legalisation of doping in high-performance sport and reasons that would lead the respondents to take performance-enhancing drugs.

Opinion on the hypothetical legalisation of doping in high-performance sport

Of the total of 347 students who responded to the questionnaire, 327 (94.24%) were against the legalisation of doping in high-performance sport, while 20 (5.76%) were in favour. None of the 52 females surveyed was in favour of legalising doping. Although only men responded affirmatively to the possibility of legalising it, there was no significant association between the sex variable and the opinion on legalising doping in high-performance sport.

Reasons that would lead them to take performance-enhancing drugs

The students were presented with five cases in which they might take performance-enhancing drugs depending on their objectives. Table 1 shows the frequencies and percentages of their responses.

With regard to the relationship between the reasons that would lead them to take performance-enhancing drugs and the sex of the respondent, significant differences were only found in the option of earning large amounts of money, in which males had a higher representation in this category than females ($\chi^2_1 = 10.688$; $p < .05$). Eighty men (27.12%) stated that they would take performance-enhancing drugs to achieve this goal, while only 3 females would (5.76%). In the remaining reasons, the tendency remains the same: 64 males (21.069%) and 9 females (17.30%) would take performance-enhancing drugs to improve performance and win a gold medal; 60 males (20.33%) and 5 females (9.61%) would do so to become one of the most successful athletes in history and become world-famous; 15 males (5.08%) and 1 female (1.92%) would do so to be admired by their social milieu (friends, peers, family, partner); and 34 males (11.52%) and 2 females (3.84%) would do so to become much more physically attractive. Therefore, the option of increasing athletic performance and winning an Olympic gold is worth noting in that it shows no difference between the sexes, as they both responded in similar percentages.

Table 1
Frequencies and percentages of the reasons for taking performance-enhancing drugs

Reason	Yes	No
To enhance my athletic performance and win an Olympic gold	72 (20.75%)	275 (79.25%)
To become one of the most successful athletes in history and be world-famous	64 (18.44%)	283 (81.56%)
To be admired by my social milieu (friends, peers, family, partner) on account of my success	14 (4.03%)	333 (95.97%)
To earn large amounts of money	82 (23.63%)	265 (76.37%)
To be much more physically attractive	35 (10.08%)	312 (89.92%)

Table 2
Relationship between reasons for taking performance-enhancing drugs and opinion on legalising doping in high-performance sports

Reasons	Legalisation of doping in high-performance sports		Total	*p*
	In favour	Against		
To enhance my athletic performance and win an Olympic gold	13 (65.00%)	59 (18.04%)	72	<.001*
To become one of the most successful athletes in history and be world-famous	11 (55.00%)	53 (16.21%)	64	<.001*
To be admired by my social milieu (friends, peers, family, partner) on account of my success	2 (10.00%)	12 (3.67%)	14	.16
To earn large amounts of money	13 (65.00%)	69 (21.10%)	82	<.001*
To be much more physically attractive	7 (35.00%)	28 (8.56%)	35	<.001*

* Category in which there is a significant difference.

There are also significant associations between some of the different reasons suggested for taking performance-enhancing drugs and the variable related to the possibility of legalising doping (Table 2). A higher proportion of students is in favour of doping to enhance athletic performance and win an Olympic gold ($\chi^2_1 = 25.037$; $p < .05$), to be one of the most successful athletes in history ($\chi^2_1 = 18.668$; $p < .005$), to earn large amounts of money ($\chi^2_1 = 20.023$; $p < .05$) and to be much more physically attractive ($\chi^2_1 = 14.457$; $p < .05$), compared to those who are against this attitude. Sixty-five percent of the respondents who stated that they were in favour of legalising doping also said that they would take performance-enhancing drugs to enhance their athletic performance and to win a gold medal, while among the respondents who stated that they were against legalising doping, only 18.04% would take performance-enhancing drugs to achieve better athletic performance and to win an Olympic gold. The only reason in which there is no relationship of this kind is when the reason for taking these drugs is to be admired for their success by their social milieu (friends, peers, family, partner).

Discussion

In this section, the results are analysed to answer the basic questions posed in this study: What do PASS students think about the potential legalisation of doping? And in what cases would they themselves take performance-enhancing drugs?

What do PASS students think about the potential legalisation of doping?

Almost all the PASS students, 94.24%, opposed the potential legalisation of doping, and only 5.76% were in favour of this possibility. These percentages contrast with those found in the study by Vangrunderbeek and Tolleneer (2010) with students taking Bachelor's degrees related to physical activity and human movement at the University of Ghent (Belgium). That study found that from 1998 to 2006, students' tolerance of the use of performance-enhancing drugs had risen. While in 1998, 10% of the respondents were "tolerant" of doping, this figure had risen to 20% in 2006. Similarly, the number of participants who were totally against doping fell from 73% in 1998 to 43% in 2006. The results of this study are more in line with those found in research with university students taking Pharmacy degrees. The study by de Saito et al. (2013) found that 90% of the respondents were against violations of doping laws, while in the study by Awaisu et al. (2015), also conducted with university students taking Pharmacy degrees, 89% stated that they were against the use of doping substances in sport. In relation to these results, the PASS students at the UV surveyed in this study seem to be more against the legalisation of doping than the students in the same courses in other faculties, but they show a similar rate of rejection of doping as university students taking Pharmacy degrees at other universities.

On the other hand, the study by Stamm et al. (2008) analysed the attitude of both the Swiss population and elite athletes towards the legalisation of doping. Eighty-six percent of the general Swiss population surveyed took a stand entirely in favour of banning doping, as did 96% of the elite Swiss athletes surveyed. In both cases, the explanation is that they considered doping to be contrary to the principle of fair play. In another study by Wanjek et al. (2007) with working athletes, a significant association was found between their attitudes towards doping and taking performance-enhancing drugs. Those who considered doping negative for health and sports ethics presented lower rates of doping behaviours. Apparently, the PASS students at the UV surveyed are as opposed to the legalisation of doping as the elite athletes in the aforementioned articles.

With regard to the studies conducted on coaches' attitude towards doping, in the study conducted by Engelberg and Moston (2015), the majority were against the presence of doping in sport and supported harsh penalties for coaches responsible for helping their athletes to take performance-enhancing drugs. Similarly, Fung

(2006) found that 19% of the coaches surveyed stated that athletes can use performance-enhancing drugs if it does not harm their health. The study by Mandic et al. (2013) found that 71% of the coaches surveyed stated that they would not suggest that their athletes take performance-enhancing drugs, and 10% of the coaches said that they would suggest that their athletes did so as long as they were sure that it would not affect their health. Therefore, the PASS students surveyed at the UV rejected doping more than the coaches in these studies.

In what cases would they take performance-enhancing drugs?

There are striking figures on the participants' willingness to take performance-enhancing drugs. At least 1 out of 5 respondents would take these drugs to win an Olympic gold or earn large amounts of money, and 1 in 6 would take these drugs to become world-famous. These three variables are related, since they summarise what success means today at the highest levels of elite sports. It is worth noting that the potentially harmful health-related effects of this hypothetical behaviour by the respondents was not explicitly addressed in the questionnaire, as it was in Connor et al. (2013) and did Mroczkowska (2011). Nor was the alteration in athletic equality stemming from athletes' taking performance-enhancing drugs explicitly stated, as it was in Connor et al. (2013), who described different scenarios with illegal or legal (ergogenic) drugs. However, the PASS students are aware of doping, and they have at least an approximate notion of the effects it could have on health, and that its presence alters athletic competitions. Therefore, we assume that there is a considerable percentage of respondents who would take performance-enhancing drugs despite knowing that they are harmful and that they go against the rules of sports. This could be a major cause for concern if we bear in mind that these students will be working as teachers, coaches, physical trainers and other professionals within the field of physical activity in the future. How is a teacher going to teach their student about fair play and sports ethics if they themselves would take performance-enhancing drugs if they could? Analysing the results of similar studies, in Scarpino et al. (1990) the main reasons given by the athletes polled for taking performance-enhancing drugs were to win a competition (63%), improve their training performance (9%), reduce pain (6%), at the request of their coaches (6%) and other unspecified reasons (16%). The study by Striegel et al. (2002) finds that the most frequent reasons cited by the athletes to justify doping is improvement of athletic performance (86%), economic profit (74%), improvement of self-confidence (30%) and social recognition (24%). Dunn et al. (2012), in turn, cited thinking that other competitors are taking performance-enhancing drugs as an important reason to justify taking them. Therefore, the respondents who thought that many of their competitors were taking performance-enhancing drugs were more likely to have taken such drugs recently (28%) than those who believed that fewer competitors were taking them (11%). This concept is the "false consensus effect", which suggests that athletes with a history of taking performance-enhancing drugs overestimate the presence of these drugs among their competitors (Morente-Sánchez & Zabala, 2013). In this regard, the PASS students seem to justify doping through reasons related to athletic performance and non-sport factors, such as money and fame, similar to some of the aforementioned studies. Nonetheless, these results differ from the others in that the first reason for justifying doping is not improving athletic performance, but rather financial gain.

The data show that females would take performance-enhancing drugs less than males. We do not know whether this is because they are afraid of harming their health, sports ethics or other reasons. The percentage of males who would take performance-enhancing drugs is higher than the percentage of females in all the reasons suggested in our study, and a significant number of these males justified taking these drugs to earn large amounts of money. The sole reason in which the percentages between male and female respondents are similar is to enhance athletic performance and win a gold medal. In this case, the proportion changes notably, as females respond almost identically as males. In the study conducted by Sas-Nowosielski and Swiatkowska (2008), males were more ego-oriented when competing, which was found to be a significant factor in having a higher likelihood of taking performance-enhancing drugs. Conversely, females' motivation was more task-oriented, a factor which has been associated with a stronger rejection of doping, although no differences were found in the attitude towards doping in relation to motivation among females. The male PASS students at the UV showed a greater willingness to take performance-enhancing drugs than their female classmates, as in the aforementioned study.

In the majority of cases, there is consistency in the relationship between taking performance-enhancing drugs and being in favour of legalising doping. The exceptions are the reasons for which fewer respondents would take these drugs, namely, to be admired by their social milieu (friends, peers, family, partner) on account of their success, and to become much more physically attractive. In the remaining situations posed, most of the respondents who would be in favour of allowing doping would do it, similar to the result obtained by Whitaker

et al. (2012), in which athletes who did not disapprove of breaking the rules were more likely to take performance-enhancing drugs. The study by Petróczi (2007) found a significant relationship between being in favour of legalising doping and favourable attitudes towards it. In the study by Kindlundh et al. (1998), males presented a significant relationship between taking performance-enhancing drugs and being in favour of doing so. Therefore, there seems to be a relationship between being in favour of legalising doping and taking performance-enhancing drugs in the PASS students at the UV, results which are very similar to those found in the aforementioned studies.

Conclusions

The following conclusions can be drawn from this study:

a) Most of the PASS students at the UV are against legalising doping (94.24%). More specifically, females are more opposed, as none of the 52 female respondents was in favour of legalising it.

b) Although most of the students would not take performance-enhancing drugs (three quarters of them in all the situations presented), the main reasons that would lead them to do so are: to earn large amounts of money (cited by 23.63%), to enhance their athletic performance and win an Olympic gold (20.75%) and to become one of the most successful athletes in history and be world-famous (18.44%).

c) Taking performance-enhancing drugs to earn large amounts of money is influenced by two different variables:

- Males would take more performance-enhancing drugs than females when the goal is to earn large amounts of money (27.12% of males versus 5.76% of females).
- The students who are in favour of legalising doping would take more performance-enhancing drugs to earn large amounts of money (65%) than those who are against legalising it (21.2%).

d) The students who are in favour of legalising doping would take more performance-enhancing drugs to enhance their athletic performance and win Olympic gold (65%) than those who are against legalising it (18.04%).

e) Taking performance-enhancing drugs to become one of the most successful athletes in history and to be world-famous is associated with being in favour of or against doping, so that students who are in favour of legalising doping would take more performance-enhancing drugs to become one of the most successful athletes in history and to be world-famous (55%) than those who are against legalising doping (16.21%).

The main limitation of this study is that it analysed data from a single school. One future prospect would be to expand the study to other schools in order to compare and check whether there are significant differences with the results of this study. It would also be interesting to conduct similar studies with students from other university degree programmes such as Physiotherapy, Teaching Physical Education, post-graduate programmes related to physical activity and sport sciences, and students in vocational training programmes related to physical-sport activities, which would also shed further light on attitudes towards doping in future physical activity and sport professionals.

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The Francoist Mirage at the University of Barcelona: Sports Facilities (1954-1958)

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Abstract

Starting in 1944, the Francoist dictatorship promoted physical education as a compulsory university subject controlled by the Falange to furnish it with ideological content. However, this political decision clashed with the reality of the harsh post-Civil War period. The University of Barcelona is a case in point, since it did not have its own sports facilities until 1957. The purpose of this study is to explain the circumstances in which these facilities were built against the background of the transformation of sports policies under the dictatorship between 1954 and 1958, and also to analyse the extent to which these infrastructures enabled more far-reaching change in the teaching objectives and methods of university physical education. To this end, documentation in the University of Barcelona's Historical Archive (the University's Sports Committee and physical education activity reports), documentation in the city's Historical Archive (the University of Barcelona's Board of Works and the Municipal Sports Committee) and newspaper library documentation from the period were examined in order to reconstruct the situation at the time. The results evince the connection between changes in the political situation and infrastructural transformations, although there is little correlation between these changes and the resistance to change of university physical education. This perspective demonstrates the clear asymmetry in sport and physical education during Franco's dictatorship between the ideological resolve of the State apparatus and the determination of local organisations committed to modernisation and which were closer to the public's needs.

Keywords: sport, University of Barcelona, facilities, Francoism, youth

Introduction and Objectives

During the 1950s, the tenets of Franco's regime changed progressively with regard to physical education and sports policies. Like the actual dictatorship, the organisation and objectives of the regime's sports policy were tailored to a modest political openness resulting from the international scenario and domestic needs. The generational changeover in its leaders (General Moscardo died in 1956), coupled with a strong interest in the internationalisation and the propagandistic use of sport, especially football (Viuda-Serrano, 2013), spawned the first attempt to modernise sports structures. This took shape particularly from the 1960s onwards, coinciding with the period of economic "developmentalism" (Santacana, 2011). This attempt at modernisation was expressed in law by the Physical Education and Sports Act of 1961, although it was most essentially embodied in a renewed vision for which the regime's leaders coined the "sport, public need" slogan, far removed from the militaristic creed of the early years (Quiroga Fernández de Soto, 2014). Against this backdrop, university physical education, which had been taught since 1944 as a compulsory subject with a strategic role in conveying the values of Falangism to young people, would also be adapted as new facilities were built to deliver a marked improvement compared to the patently inadequate early stage (*La Vanguardia*, 10.11.1944). These improvements, which in the case of Barcelona's university district took the form of the construction of the University of Barcelona's sports facilities in 1957, were not matched by any updating of the content, methods and objectives of physical education as a subject, which remained under the control of the Spanish University Student Union (*Sindicato Español Universitario* or SEU) run by the Falange (Ruiz Carnicer, 1996), and aroused scant interest among young Catalan university students. Hence, in reality, and at universities, in this case the University of Barcelona, the infrastructural changes which brought about unquestionable improvements in sports facilities (Rivero, 2008) do not seem to be actually correlated to the updating of physical education as a subject at the university, which continued to be compulsory, imparted in line with traditional attitudes and by teachers with little training and a militaristic profile.

Given the dearth of specific studies on university sport during the dictatorship in Spain as a whole and in the case of Catalonia, the main aim of this research was to explain the circumstances in which the University of Barcelona's sports facilities were created as part of the process of change in sports policies under the dictatorship in the second half of the 1950s. Alongside this general objective, two more specific objectives were pursued: a) to contextualise the correlation between this process and the period of early international opening up of sports events in the Catalonian capital, and b) to analyse to what extent building sports infrastructure was related to a more far-reaching transformation in teaching objectives and methods in the compulsory subject of physical education at the university.

Methodology

In order to accomplish these objectives, this research was addressed as a historiographic study embedded in the social sciences, given that researching the past involves investigating a dimension of society, as the historiographic method is a methodological practice in itself. Therefore, the distinctive techniques of the historical method were employed, which in this case involved finding, analysing and gathering data from documents for subsequent interpretation of the archive sources, which were triangulated with other newspaper library and published literature sources.

Three different types of documentary sources were explored in this research. Firstly, the documentation in the University of Barcelona's Historical Archive concerning the viewpoint of the University's Sports Committee and in the activity reports which provided information about university physical education and its content in the period prior to 1957. Secondly, the municipal perspective was factored in, leveraging documentation from the University of Barcelona's Board of Works (crucial for analysing the infrastructure plan and its predecessors) and from the Municipal Sports Committee, set up in 1952, kept in the city's Historical Archive. Finally, data were gathered from documentation in the newspaper libraries of the period and other Falange-related activities in order to analyse the sociopolitical and ideological framework associated with sport and the university.

Physical education at university and its legal enforcement

By making physical education compulsory at university in March 1944 (Official State Gazette of 10.04.1944), together with political and religious education, the Francoist regime provided legal coverage for its purpose of indoctrinating young people through university teaching. Nonetheless, the means required to accomplish this purpose had to be furnished, starting with the

appointment of the lecturers who would deliver the appropriate instruction, as well as the equipment and infrastructure required to do sports. Most universities had major shortcomings in these aspects, and the University of Barcelona (UB) was no exception.

As for faculty, some leaders (Gastesi, 1943) suggested as early as 1943 setting up a National School of Physical Education to deliver specialised training for these lecturers to ensure that the people who were to teach university physical education classes would have sufficient resources. Until this school could be founded, the instructors came from the San Carlos School, as a department in the Faculty of Medicine in Madrid, or from the Central Gymnastics School in Toledo, which explains why health and military aspects prevailed in teaching, which also evidently catered to the Movement's doctrinal interests. The first National Institute of Physical Education (INEF) was created following the Physical Education Act of 1961, known as the Elola-Olaso Act, because José Antonio Elola-Olaso was the national head of physical education at that time and hitherto university teachers in the subject had little specific training and were also appointed on the strength of their ideological affinity with the regime.

Sports facilities were perhaps even in shorter supply than faculty, given that the UB at that time did not have its own facilities and had to make arrangements with private organisations (such as Real Club Deportivo Español and the Baños de Barcelona company) or use the facilities of the Youth Front or the Women's Section of the Falange, namely, and by way of example, those available in the Industrial School and in some student halls of residence. The University's Board of Works was not set up until 1950. Building the university's own sports facilities had to wait until July 1952, when the Board, at a plenary session, expressed its interest in:

> "[…] the availability of land near the university complex suitable for the establishment of the university sports area envisaged in the general building plan, and it was agreed that this objective would be pursued until the land with the best technical and financial conditions was found." (UB Board of Works, 1952-53)

This was a highly unstable situation which was gradually turned around using existing resources and resulted in the construction of the university sports area on what is now Avinguda Diagonal between 1954 and 1958. It coincided with the hosting of many other sports events in the course of the decade in Barcelona, which in turn helped to further the city's international sports and tourism appeal, coinciding with the regime's greater political openness.

The sports setting in Barcelona

During the 1950s, over twenty sports events were hosted in the city, even though it had few major facilities. In fact, in 1952 only the Montjuïc Stadium and Swimming Pool and the basketball and tennis courts in the same area were regarded as being municipal-owned (Municipal Sports Committee, 1952). The lack of sports facilities meant that many of the events had to be held in private venues (Table 1).

The shortage of sports facilities was obvious, yet social circumstances forced the public authorities to allocate funding to other priorities directly tied to survival. The post-Civil War period was a time of famine in which basic foodstuffs were rationed, compounded by numerous other hardships which meant that people were hardly inclined to do sport (Pujadas & Santacana, 1997).

Nevertheless, as of the 1950s, and with the regime's gradual international opening, the socio-political situation slowly changed, also translating into a certain generational shift in government, with the emergence of leaders closer to Catholic liberalism. Examples of this are Fernando María Castiella (who sponsored adding the right of association to the 1945 *Fuero de los Españoles* if the objectives were legal, and a timid move towards freedom of speech, as long as it did not conflict with the fundamental principles of the State), and Alberto Martín Artajo (who contributed to the signing of the Concordat with the Holy See in 1953), also in view of the power wielded by the Church in the regime, and which led to the International Eucharistic Congress being hosted by Barcelona in 1952 (Colomer & Calsina, 1978). Similarly, some ministries were infused with new ideas, especially by Joaquín Ruiz Giménez as head of Education (1951-1956). These were all signs of inevitable change in the system and sports could not be left out of the equation.

Although physical education had been made a compulsory university subject in 1944, and for a few years was imparted in borrowed and rented venues in Barcelona, it was now becoming essential to build proprietary facilities to accommodate it. This was due to the numerous domestic and international sports events held in the city in the course of that decade and which additionally afforded the city greater exposure beyond its borders.

Table 1
Spanish and international sports events in Barcelona during the 1950s

Year	Sport	Event	Venue	Ownership
1950	Basketball	Spanish Cup Final	Las Arenas Bullring	Private
1951	Motorcycling	Spanish Grand Prix	Pedralbes Circuit	Public
1951	Roller hockey	World and European Championship	Pavelló de l'Esport (Sports Hall)	Public
1951	Motor racing	Formula 1 Spanish Grand Prix	Pedralbes Circuit	Public
1953	Tennis	1st Conde de Godó Trophy	Real Club Tennis Barcelona (Barcelona Royal Tennis Club)	Private
1953	Multisport	National University Games in Barcelona	Pavelló de l'Esport (Sports Hall) La Bordeta Football Ground Olympic Stadium Guinardó Stadium La Salut Courts	Public Public Public Public Private
1954	Motor racing	Formula 1 Spanish Grand Prix	Pedralbes Circuit	Public
1954	Roller hockey	World and European Championship	Pavelló de l'Esport (Sports Hall)	Public
1955	Ice-skating	World Figure Skating and Dance Championship	Palau d'Esports (Sports Arena)	Public
1955	Motorcycling	1st Montjuïc 24-hour Race	Montjuïc Circuit	Public
1955	Basketball	Spanish Cup Final	Pavelló de l'Esport (Sports Hall)	Public
1955	Miscellaneous	Mediterranean Games (16-25 July)	Palau d'Esports (Sports Arena) Montjuïc Stadium Municipal swimming pool	Public Public Public
1956	Ice-skating	World Figure Skating, Dance and Racing Championship	Palau d'Esports (Sports Arena)	Public
1957	Football	Opening of FCB's Camp Nou ground	FCB Stadium	Private
1957	Cycling	The Tour de France visits Barcelona	Montjuïc Circuit	Public
1957	Football	Spanish Cup Final	Montjuïc Stadium	Public
1958	Football	Inter-Cities Fairs Cup Final	Camp Nou	Private
195 and 1958	Roller hockey and judo	European Championship	Nou Palau d'Esports (New Sports Arena) in Lleida St.	Public
1958	Billiards	World Three-cushion Billiards Championship	Barcelona Billiards Club	Private
1959	Motor racing	1st Barcelona-Sitges International Rally	Barcelona to Sitges road	Public
1959	Basketball	Spanish Cup Final	Palau d'Esports (Sports Arena)	Public

Source: compiled by the authors from *La Vanguardia*, barcelonasportiva.blogspot.es, Pernas (2015a, b).

The City Council of Barcelona was also aware of the recognition that sport was bringing to the city, prompting it to set up the Municipal Sports Office in 1948, together with its first set of regulations:

> "[...] for the successful expansion of Sport in Barcelona [...] capable of coordinating, encouraging, managing and fostering the expansion of Sport by all means, extending it to all social classes and channelling the performance of Sport in such a way that it is not the exclusive privilege of the few or the livelihood of many others." (Municipal Sports Office, 1948)

Its first head was Epifani de Fortuny, Baron of Esponellà, who had been a director of FC Barcelona before the Civil War and promoted school swimming courses at the municipal pool on Montjuïc and also the holding of the Mediterranean Games in the city in 1955 as an event which would help to transform and modernise Barcelona (he held the post at the Office from 1948 to 1951). He was followed by Lluís de Caralt (from 1951 to 1952), Carlos Pena Cardenal (from 1952 to 1955 who went on to become Cabinet Officer for Sport on the City Council in 1963), and finally Joan Antoni Samaranch (from 1955 to 1961).

Accordingly, given the local authority's keen interest in promoting sport, and bearing in mind the shortcomings both in general and at the university in terms of venues, the call to build facilities gradually gelled. In fact, for years the university faculty teaching the subject had been singling out "[...] the deficiencies occasioned by the dearth of sports facilities

and insufficient equipment", calling for permanent venues, or at least a satisfactory stopgap solution:

> "[…] it should be stressed that the main difficulty lies in the lack of adequate university-owned pitches and facilities, and while this main problem is being resolved, hiring a sufficient number of adequate pitches and facilities provisionally may offset the evident shortage." (UB End of Academic Year Report, 1947-48)

Thus, the UB Board of Works, constituted in 1950 "[…] to effectively and quickly implement the plan to expand the Schools of the University of Barcelona […]" (Official State Gazette of 16 February 1951), explicitly stated this interest in sports matters in its 1952 and 1953 Reports in terms of the possible site of the facilities, actually the same location as the one that FC Barcelona was considering for its new Camp Nou football stadium, although it would ultimately be reserved for the university. This document devoted an entire chapter to university sports facilities and, acknowledging their importance, it established that:

> "[…] on the land acquired by the Board and in the southern sector of Avenida del Generalísimo Franco adjacent to the municipalities of Hospitalet and Esplugas, it is planned to build the university sports facilities, a compulsory addition to the teaching facilities." (UB Board of Works, 1952-53)

Another example of the growing attraction of university sport for the regime was the 1953 National University Games in Barcelona. Franco himself stressed this in comments to *La Vanguardia* on 24 March of that year in terms of the "political importance of sports instruction, one of the surest ways of contributing to the greatness of Spain", since in the dictator's view "the mission of university students [which] does not end at the walls of the university but rather extends to all areas of national life." Accordingly, he added that "the Movement must be nurtured by this eagerness to excel in sports, since physical training contributes to the strength of Spanish youth and thus prepares them physically to render the most effective service to the Nation." Two days later, the same newspaper reported a conversation with the National Head of the Spanish University Student Union (*Sindicato Español Universitario* or SEU) Jorge Jordana Fuentes, who referred to "their [the National University Games] impact on the life of the city and also about the imminent plans for university sports facilities" (*La Vanguardia*, 26.03.1953).

This apparent consistency between the remarks by the SEU leader and the head of state himself in relation to university sport and the need for new infrastructure was reaffirmed some days later by the Minister of National Education, Ruiz Giménez. Linking the National University Games to the lack of university sports venues in the city, he confirmed the importance that had been attached to sports facilities in the planning of new university buildings, while also applauding the organisational success and results of the National University Games held in Barcelona, because they were "[…] a celebration of how all the educational power of sport has been fully integrated into the ideals of the Movement and balances and harmonises it […]" (*La Vanguardia*, 31.03.1953).

This demand had already been legally formalised through the publication in the Official State Gazette no. 314 of 09.11.1952 of the Decree of 24 October 1952 on the acquisition of land to complete the Barcelona University Zone, which stated, in Article 2, "the pressing need for the work for the construction of sports pitches in the Avenida del Generalísimo Franco in the city of Barcelona".

Siting and building university sports facilities

FC Barcelona planned to build a new stadium, as approved by its Assembly in July 1948 (Santacana, 2007). With this in mind, in November 1950 the club said it was particularly keen on acquiring the land at the end of what is now Avinguda Diagonal and on which it had taken out a purchase option before the University also considered acquiring it.

In fact, the UB Board of Works was fully aware of the Club's intention and referred to the negotiations conducted in its Annual Report for the 1952-53 academic year:

> […] the Board was informed that FC Barcelona was planning to build a stadium in an adjacent area. The Board of Works got in touch with the Chairman of the Club and has been in constant contact with him since then to coordinate and align the interests of the University with the Club's plans, insofar as the latter, once completed, might affect part of the land acquired."

In lockstep, these negotiations were also recorded in the minutes of Futbol Club Barcelona's Board of Directors meetings in 1952-54, such as those dating from 26 February 1953 which state that: "Mr Vallés reported to the Board on the most recent meetings held with the Board of Works of the University of Barcelona concerning the final site of our new stadium and the agreements reached in principle."

The disputes between both organisations coursed for more than three years and were ultimately settled in the University's favour in 1954 in a scenario in which its shortcomings in sports infrastructure were made patent once again:

> "As FC Barcelona has resolved the problem of the building of its stadium on the land it owns between the Maternity Hospital and the Las Corts Cemetery, a problem which for so long had thwarted the construction of the sports facilities planned by this Board, whose completion will cater to a most pressing need, since it will not only allow students to do sport but will also be used for physical education, for which there are currently no adequate facilities, to be taught, the Plenary Meeting held on 26 February agreed to immediately take over the plots of land to complete the sports area […]." (UB Board of Works, 1954)

The UB's ownership of the land was thus finally acknowledged, and work on building the facilities had to begin. Before that, however, it was thought expedient to set up a 'University Sports Committee' to provide the University with the technical advice it needed and to produce regulations governing the future use of the facilities. The Committee was set up on 26 March 1954, and had seven members: the Rector, a professor representing the faculty, the Director of Physical Education Teaching at the University, the two Heads of Sports of the men's and women's sections of the SEU, a representative of the University Sports Club and a specialist adviser.

One year later, the Decree of 18 March 1955 (Official State Gazette of 01.04.1955) approved the City University of Barcelona Sports Facilities plan, assigning a budget of more than 15 million pesetas (currently equivalent to more than €90,000) which was to be put out to tender.

Between 20 April and 19 May 1955, seven companies submitted bids for the building work, reducing the final cost by between 2% and 19.2%. On 25 May, the plenary meeting of the UB Board of Works awarded the commission to the company that had tendered the lowest bid, namely Construcciones Sulleva, S.A. (UB Board of Works, 1955).

Although the work was completed in little more than a year (December 1956), the UB Sports Committee refused to accept it on the grounds that it was defective. As a result, and following an exchange of several letters which led the cost of the repairs to be passed on to the University and to the builder in turn, the official ceremony for the provisional acceptance of the work was finally held on 12 March 1957.

However, when the University's Governing Board decided to entrust the management of the operation and the administration of the facilities to the Sports Committee, the latter made a "lengthy visit to the site to check the state of the pitches and courts". In the course of this visit, major defects were identified, which the builder would have to remedy, since some areas, including the rugby pitch, the football training field, the large concrete track, the fronton court, the volleyball court and some tennis courts were found to be *unusable*. They also emphasised the poor quality of the changing rooms and the incorrect layout of the Olympic rings at the entrance to the facilities (UB University Sports Committee, 25.05.1957).

Although *La Vanguardia* reported on 12 June 1957 that "the sports facilities have already been built at the end of the Avenida del Generalísimo Franco and are about to be opened", the official opening actually took place more than one year later due to all the repairs required on the original construction work.

With all these setbacks, and the raft of add-ons subsequently called for to render the infrastructure as complete as possible (for example, metal fences, furniture, lighting, etc.), it was not until October 1958 that the official opening took place. This was despite the fact that the facilities had been in use for university sports for some time, as reported in the press at the time: "the facilities have been in use for some time now, but they have not yet been officially opened, which means that this is a new event" (*La Vanguardia*, 18.10.1958).

Conclusions

This article has described the background to the construction of the UB's sports facilities, which the different stakeholders at the time had long since been claiming.

However, notwithstanding the formal appearance of the regime's accomplishment of objectives related to the university, the existence of the new facilities was little more than a cosmetic touch-up for the physical education subject, a subject not highly rated by students, who perceived it as a burden devoid of any real and meaningful content for their intellectual training (the statistical table for PE in the 1950-51 academic year shows attendance rates of 50% for the subject), or by its faculty, who felt they were undervalued.

Indeed, the Secretariat General of the Movement placed PE teachers within the "special lecturers" category, and therefore belittled in comparison with the lecturers of other university subjects, and also shorter in number and in specific training. In actual fact, neither did

the actual system seem to regard it as efficient (the university district's SEU failed to assign all the students), given that it failed to invest sufficient resources to make it a real tool for indoctrinating young people, and was unable to make its syllabus more attractive. As a result, students were apathetic towards it and they continued to regard it as a "Mickey Mouse" subject.

With an evident rift between university students and Franco's regime, which was especially repressive in Barcelona through faculty purges and the persecution of the Catalan language, the students' attitude was a sign of the paradigm shift taking place in society in politics and sports alike.

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Evolution in the Sports Habits of Sport Sciences Students in Spain

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Abstract

The purpose of this study was to analyse the evolution of the sports habits of Physical Activity and Sport Sciences students in Spain. It is a quantitative, exploratory and descriptive study. The sample is comprised of 1043 students divided into three different academic years: 357 (34.2%) were studying in the period 1991-92, 364 (34.9%) in 2012-13 and 322 (30.9%) in 2016-17. The majority are males (74.3% compared to 24.7% females) and their mean age is 21.7 (*SD*=3.077). A questionnaire with a reliability index of α=.822, .836, .877, respectively, was used to collect the data. The results show that the student profile is clearly athletic, with sports backgrounds in their families, a trend that increased over the years, although once they started their degree programmes the number of sports they practised decreased. Football is the majority sport, which increased in the academic years studied and decreased after the students enrolled in the school. Their sports practice is associated with federations, and therefore the majority compete nationally and regionally.

Keywords: sport, higher education, physical education, students, physical activity

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New Olympic Sports for Tokyo 2020: Karate. Photo: Haifa, Israel - July 11, 2017: The Karate competitions during 20th Maccabiah Games at the Romema Arena.

Introducction

Research into the sports habits of university students enrolled in Physical Activity and Sport Sciences (PASS) has been common in the specialised literature in Spain since the old national physical education institutes (INEF in Spanish) were founded. The earliest studies focused on a sample of students from a specific school (De la Cruz et al., 1988; García et al., 2012; Márquez & Zubiaur, 1990; Madera & González, 2003; Mosquera-González & Rodicio-García, 1995; Parera & Solanellas, 1998; Pérez et al., 2005). Some of them capture the differences before and after the time when the students started their programmes (Mosquera-González & Rodicio-García, 1995; Pérez et al., 2005), while others focus more on the knowledge learned in the degree programme (Madera & González, 2003).

Internationally, the topic has been associated with studying healthy living habits and levels of practice using the Physical Activity Questionnaire (IPAQ) or questionnaires developed ad hoc (Bednarek et al., 2016; Durán et al., 2014; Fagaras et al., 2015; Loch et al., 2006; Rangel et al., 2015; Soguksu, 2011; Ureta, 2015).

Another emerging avenue of research is comparative studies. Mosquera-González and Rodicio-García (2014a, 2014b) analyse the population of Physical Activity and Sport Sciences students in the 1990s and today. Their study identifies masculinisation, the practice of several sports and a strong bond with the sport, which spans almost half their lives. A tendency to modernity detected back in the 1990s continues, meaning relationships with federations and competition (García Ferrando, 2006), in addition to a decrease in sports practice after entering the school. The masculinisation of studies is also reported by Porto (2009), as well as by Serra and Soler (2013) and Garay et al. (2018), who identify a decrease in applications to the schools in the last 25 years and in the percentage of women who ultimately study in them in both Catalonia and the Basque Country. Internationally, the study by Kwan et al. (2012) analyses two groups of students (1994-1995 and 2006-2007) and reaches the conclusion that physical activity decreases with time, especially when students start university.

Another comparative study is by Montero and Gómez (2006), who offer a broader perspective by comparing students from five schools at three Galician universities. This study found no major differences in terms of the taste for sport, regular practice and association with federations in both Bachelor's and diploma students, although the INEF students are slightly more closely associated with competition. A comparison of schools at different Spanish universities was also conducted by Montero (2008); this study highlights that at the INEF schools in Galicia, 81.9% of the students do sport and are the most closely associated with federations and competition.

There has also been an interest in learning the sports habits of students in Teaching Physical Education (PE), as shown by the studies by Arbinaga et al. (2011) and López-Sánchez et al. (1994), which compare several different graduating classes; the study by Zagalaz et al. (2009), which examines students' sport practice before and after entering the school; and the study by Gago et al. (2012), which compares them with students in the other specialisations of Early Childhood and Primary Education.

Another perspective is the study of the population of university students, including those on PE courses. In Spain, one prominent study by Ruiz et al. (2001) observed that the Education students, including students in the Diploma programme to be a PE Teacher, come in first in terms of the number of practitioners of physical-sport activities in their free time. In a similar vein are the studies by Awadalla et al. (2014), Bergier et al. (2015, 2016), Brown et al. (2008), Fagaras et al. (2015), Martínez-Lemos et al. (2014), Nasui and Popescu (2014), Olutende et al. (2017), Sechi and García (2012), Sigmundová et al. (2013) and Valdés-Badilla et al. (2015). Similarly, there are comparative studies of PE students in different countries, such as Haase et al. (2004), Kondric et al. (2013), Bergier et al. (2016, 2017) and Sindik et al. (2017).

From the methodological standpoint, the majority of the studies are quantitative and latitudinal, analysing a sample of students at a given point in time (De la Cruz et al., 1988; Madera & González, 2003; Márquez & Zubiaur, 1990; Montero & Gómez, 2006; Montero, 2008; Mosquera-González & Rodicio-García, 1995, 2014a; Parera & Solanellas, 1998; Pérez et al., 2005; Zagalaz et al., 2009), with fewer longitudinal studies (Kwan et al., 2012; Ruiz et al., 2001).

This study seeks to ascertain the evolution in the sports habits of PASS students in Spain in the last 25 years. With this purpose in mind, it analyses the data in a twofold dimension: according to the group studied (academic years 1991-92, 2012-13 and 2016-17), and whether they refer to before or after enrolling in the university.

Methodology

A quantitative methodology was used with a questionnaire as the data collection instrument; it is fundamentally descriptive because it focused on reporting on the sports habits of PASS students by examining the direct responses they provided in natural settings, such as the classroom.

To this end, we used three samples of students enrolled in these programmes at the University of La Coruña in different periods: in the 1990s, specifically in the 1991-92 academic year, when the first class of students graduated with their Bachelor's from the INEF in La Coruña; one decade later, in the 2012-13 academic year, when the first class of Sport Sciences graduated from the same university; and finally, in the 2016-17 academic year, when the second class of Bachelor's students graduated.

Participants

A total of 1,043 students took part in this study, 357 (34.2%) of whom studied in the 1991-92 academic year, 364 (34.9%) in 2012-13 and 322 (30.9%) in 2016-17. The majority are males, 74.3% compared to 24.7% females. The mean age was 21.7 ($SD = 3.077$), and 26.7% were in their first year when the data were collected, 24.5% their second year, 16.3% their third year, 23% their fourth year, and 8% their fifth year (this percentage is low because it only includes the sample from 1991-1992, since the current programmes last four years).

Procedure and Instrument

The participants, all of whom were PASS students, were asked to participate via an informative letter to the professors of their core courses in order to obtain a higher response. Once approval was secured, the researchers went to the classroom assigned by the cooperating professor and the students' informed consent was requested so that they could complete the questionnaire. Therefore, the sampling was incidental, and all the students attending each session completed the questionnaire. The process unfolded without incident, always in the presence of the research team to ensure that the questionnaire was properly administered and to help students to fill it out. The participants were informed that the questionnaires were anonymous and that the data would only be used for the research.

The instrument was developed ad hoc in the 1990s and was modified in 2012 to adapt it to the social and research context at the time in order to administer it to the other two groups of students. It is broken down into four sections: identifying data, sociocultural habits, sports habits and life habits. The last two sections collected data before and after enrolment into the degree programme. This article focuses on the sports habits of the students once they enrolled in the Sport Sciences degree programme.

When updating the instrument, we enlisted the participation of professors and students in the Faculty of Sport Sciences to validate it. Initially, we asked them to respond to the questionnaire and to highlight, beside each question, any comments they had on two aspects: format and content. After the research team reviewed the notes, they were asked to join a working group session to analyse the suggested improvements and take decisions. The analysis of their input advised updating the language, changing the structure and expanding it to include several aspects which were not included in the original version. The reliability of the instrument was measured via Cronbach's α, which yielded overall results for the dimension being studied of 822, .836 and .877 in each group studied.

The study was conducted in accordance with the Code of Ethics of the World Medical Association (Helsinki Declaration) and approved by the Research and Teaching Ethics Committee at the University of La Coruña, where the authors work.

Data Analysis

We combined descriptive and inferential statistics, reliability analysis of the instrument, contingency tables and measures of association. Within the latter, the Pearson χ^2 test was performed to analyse the relationship between the categorical variables (background such as athletes in the family, a climate conducive to sports, association with federations and categories in which they compete) by academic year and before or after entering the school. To find out whether the number of years playing sport differed by academic year, a one-factor ANOVA factor analysis and a post-hoc Tukey test were conducted, which enabled the specific differences among academic years to be pinpointed. The data were processed and analysed using version 22.0 of the SPSS statistical programme for Windows.

Results

To analyse the evolution of sports habits in the different academic years studied, the three groups were studied with the emphasis on the following variables: sports background and favourable climate in the family, number of sports played, number of years played, the sport played, whether they are federated, whether they compete and if so at what level.

The students participating in the research have a sports background in their families, which varies by academic year (Table 1); there is an upward tendency as the years go by, with proportions ranging from 51.1% in the 1990s to 72% today. This difference is statistically significant ($\chi^2 = 33.503$; df = 2; $\alpha = .000 < .05$) and increases as the years go by. The situation is different in terms of whether or not there was a favourable climate for playing sports, with minimal differences ranging from 87.2%, in the 1990s to 88.5% in academic year 2016-17; these differences are not significant ($\chi^2 = .340$; df = 2; $\alpha = .843 > .05$) according to the academic year.

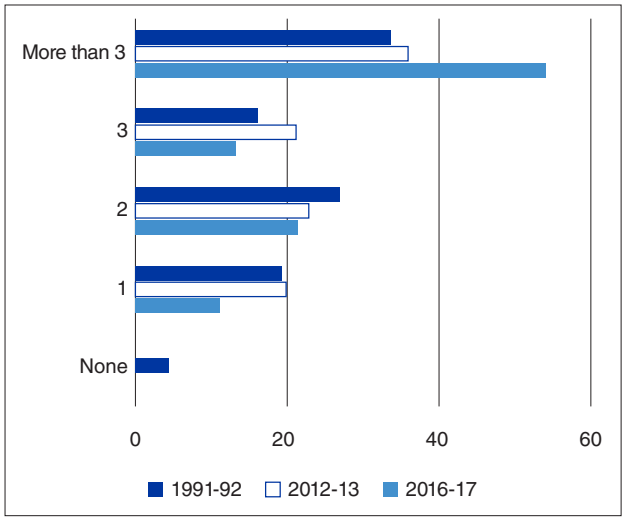
The student profile is clearly athletic, although once they begin their Sport Sciences programme, the number of sports they play decreases (Figures 1 and 2). Before enrolling in the schools, the highest percentages were found in the category of more than three sports, after which doing two sports predominates. Another noteworthy datum is that no one stated that they did not regularly play sports after enrolling in their university programme.

Table 1
Sports background and sports environment

	1991-92		2012-13		2016-17				
	n	%	*n*	%	*n*	%	χ^2	*df*	Sig.
Sports background	182	51.1	238	65.4	232	72	33.503	2	.000
Sports environment	292	87.2	304	88.4	277	88.5	.340	2	.843

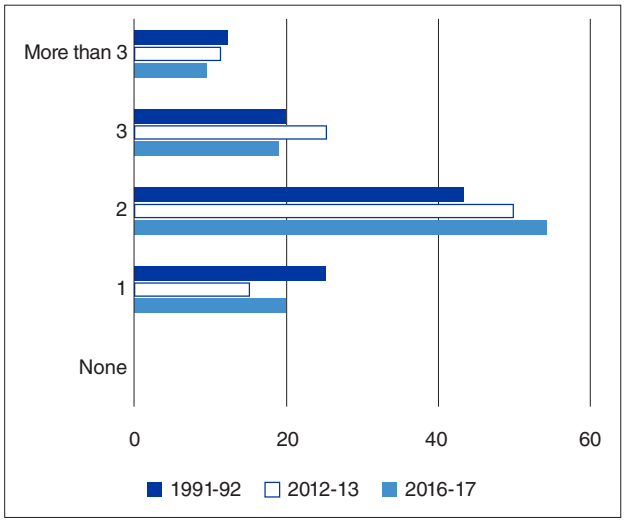
Source: Authors.

Figure 1
No. of sports practised before



Source: Authors.

Figure 2
No. of sports practised after

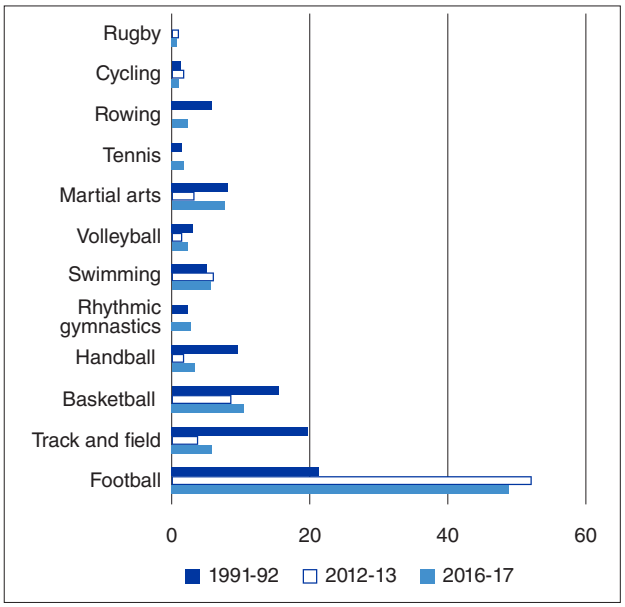


Source: Authors.

Of the sports played (Figures 3 and 4), football is the most common, although it diminishes once the students enrol in the PASS programme. They do other sports, such as track and field, basketball, martial arts and handball, to a lesser degree. As the years go by, there is a wider range of sports played, but the trend of the model remains steady, with a clear predominance of football in all three groups, both before and after enrolling in the school.

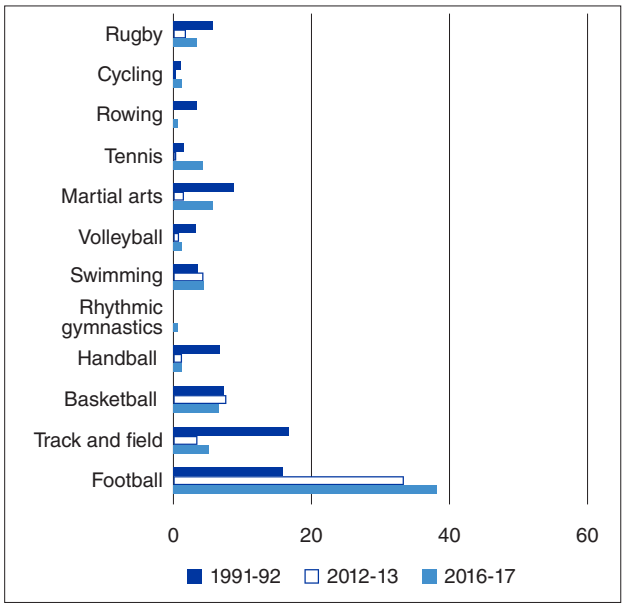
The mean number of years they played sports was 7.66 (*SD* = 3.991) in the 1990s, which rises to 11 years in the other academic years analysed. These differences are significant, as shown by the results of the ANOVA performed ($F = 94.185$; df = 2; $\alpha = .000 < .05$). The

Figure 3
Sports practised before



Source: Authors.

Figure 4
Sports practised after



Source: Authors.

Table 2
Association with federations and competition

		1991-92		2012-13		2016-17				
		%	*n*	%	*n*	%	χ^2	*df*	Sig.	
Federated	Before	309	91.2	326	93.1	299	94.0	2.139	2	.343
	After	179	68.8	179	58.1	158	59.6	7.774	2	.021
Compete	Before	318	91.9	327	92.9	314	97.8	11.933	2	.003
	After	166	60.6	190	56.9	171	58.0	.875	2	.646

Source: Authors.

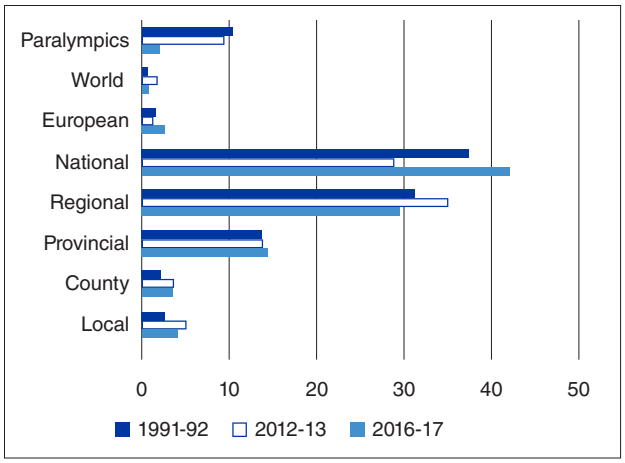
post hoc test (Tukey's HSD) reports that these differences are found in the groups from the 1990s and 2012, and between the 1990s and 2017 ($\alpha = .000 < .05$, in both).

Playing these sports is associated with federations in all three academic years studied and rose over the years (Table 2), with a statistically significant difference in federated sports after enrolling in the school, which was the highest in the 1990s ($\chi^2 = 7.774$; $df = 2$; $\alpha = .021 < .05$). The majority – more than 90% – have competed, and this figure rises progressively in the three groups before they enrolled in their PASS programme, with differences which are not significant. Once enrolled, the differences are statistically significant, being highest in the 1990s ($\chi^2 = 11.933$; $df = 2$; $\alpha = .003 < .05$).

The categories in which they compete before entering the school are primarily national (37%) and regional (31.1%), with statistically significant differences ($\chi^2 = 35.518$; $df = 14$; $\alpha = .001 < .05$) (Figure 5). Over the years, the number who compete nationally increased in 2016-17 (41.9%) and increased regionally in 2012-13 (34.9%), although the differences are not statistically significant. A considerable number of students compete in the Paralympics (10%), although this rate diminishes over the years.

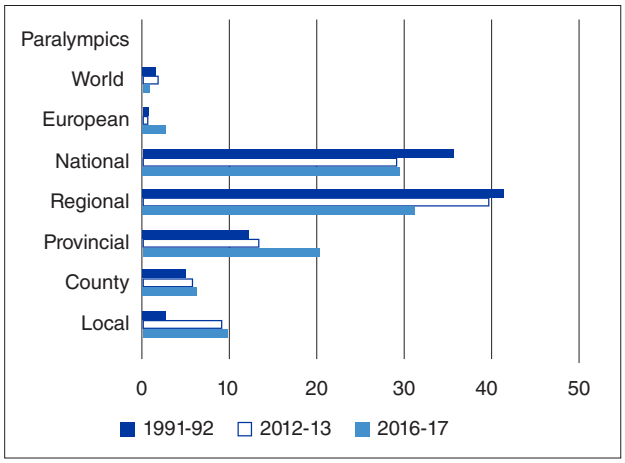
The comparison between before and after the moment when respondents enrolled in the school (Figures 5 and 6) reveals that in the 2016-17 academic year there was a downswing in the number who competed nationally (going from 41.9% to 28.5%), while those who competed regionally (from 29.5% to 39.2%) and provincially (14.6% to 20%) increased. This same trend was found in the 1990s.

Figure 5
Competition level before



Source: Authors.

Figure 6
Competition level after



Source: Authors.

Discussion and Conclusions

The interest in the sports habits of PASS students has been and continues to be a topic of interest in the specialised literature. The first noteworthy point is that this is a degree programme pursued primarily by men (De la Cruz et al., 1988; Durán et al., 2014; Garay et al., 2018; García et al., 2012; López-Sánchez et al., 1994; Madera & González, 2003; Márquez & Zubiaur, 1990; Montero, 2008; Pérez et al., 2005; Porto, 2009; Serra et al., 2014; Serra & Soler, 2013).

In order to understand and explain this fact, Serra et al. (2014) believe that a feminist theoretical perspective is needed which emphasises gender stereotypes, recognition of the hidden agenda and hegemony of male culture in studies, and acknowledgement of the neoliberal discourse in society.

Information on the existence of a sports background in the family is not collected in all the studies to which we have had access; however, when it is addressed, this influence is found to exist, as it does in this study, and to increase over the years (García Ferrando, 2006; Mosquera-González & Rodicio-García, 2014a, 2014b; Sukys et al., 2014). From the standpoint of playing sports, the profile identified in the PASS students is clearly athletic, in concurrence with other studies (García et al., 2012; López-Sánchez et al., 1994; Madera & González, 2003; Márquez & Zubiaur, 1990; Montero, 2008; Mosquera-González & Rodicio-García, 1995; Pérez et al., 2005; Ruiz et al., 2001; Zagalaz et al., 2009).

In terms of the number of sports played, playing more than one is the most common, since they play more than 3 sports. This trend matches the data provided by De la Cruz et al. (1988), Madera and González (2003) and Mosquera-González and Rodicio-García (2014a, 2014b). In terms of sports played, football is the most common one (Mosquera-González & Rodicio-García, 1995, 2014a, 2014b; Parera & Solanellas, 1998; Pérez et al., 2005; García et al., 2012), although other studies also cite track and field, gymnastics and basketball (De la Cruz et al., 1988; López-Sánchez et al., 1994; Márquez & Zubiaur, 1990).

Once they start their university studies, both playing sports and the number of sports played diminishes, a trend also found in other degree programmes (Madera & González, 2003; Pérez et al., 2005), although some have, in fact, found opposite results (Fagarasa et al., 2015; García et al., 2012; Nasui & Popescu, 2014; Ruiz et al., 2001; Sigmundova et al., 2013; Zagalaz et al., 2009). These changes may be explained by what Puig (1997) termed *sports itineraries*, namely fluctuations in sports engagement according to each subject's biography.

Virtually all the students are associated with competition and federations, which was detected in the early studies and remains true (De la Cruz et al., 1988; Madera & González, 2003; Márquez & Zubiaur, 1990; Montero, 2008; Montero & Gómez, 2006; Mosquera-González & Rodicio-García, 2014a); however, the rate drops significantly once they start university (Mosquera-González & Rodicio-García, 1995; Pérez et al., 2005).

In the Spanish population survey, García Ferrando (2006) detected that sport has been globalised and is now post-modern, as opposed to modern competition- and federation-based sport. What is noteworthy about this study is that the trend found in PASS students is the opposite of the Spanish population overall, regardless of the group studied. In short, the student profile does not promote social changes in sport; on the contrary, it reproduces traditional models of modern sport

practice, types of sport and masculinisation which are at odds with post-modern society. A self-perpetuating closed circuit has been created: students reach school with a modern profile and the school reproduces and legitimises it.

In this line, it would be interesting to reflect on the training of PE professionals, especially with respect to the beliefs of the students being trained, and through whose filter they will interpret what they are learning. Currently, training actions are not effective enough to change the beliefs, attitudes and values that the students bring with them (Carreiro et al., 2016; McKenzie, 2007; Villaverde et al., 2017). As Kirk and Oliver (2014) state, there should be a better interconnection between research and practice.

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Sports Education and Introduction to Invasion Sports in Early Primary Education

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Abstract

The purpose of this paper was to examine the evolution of the game performance and the game knowledge of second-year primary education students when the sports education model is used in the introduction to invasion sports. The season was based on the modified "the five passes" game. The sample consisted of 34 students (22 boys and 12 girls, 11 indigenous and 23 immigrants) between the ages of 7 and 8 years (M=7.53; SD=.50). Two specialist teachers led the course, one a beginner and the other an expert. A quasi-experimental design was conducted featuring pretest, posttest and retest measures. Qualitative and quantitative measures and instruments were used to capture teacher and student perspectives. Video analysis (game performance using the Game Performance Assessment Instrument, [GPAI]), interviews, diaries and expert analyses were employed. With respect to the GPAI, the intragroup comparisons reported significant pretest-retest increases in the total sample both in decision-making (Z=−2.294; p=.022) and in game performance (Z=−2.254; p=.024). Significant differences were also observed in relation to nationality. The qualitative analysis and the experts' analyses coincided with the quantitative findings concerning the improvement of tactical-technical aspects and game knowledge. The model proved to be effective in introducing young students to invasion games.

Keywords: tactical understanding, gender, nationality, invasion games

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New Olympic Sports for Tokyo 2020: Karate. Photo: Haifa, Israel - July 11, 2017: The Karate competitions during 20th Maccabiah Games at the Romema Arena.

Introduction

The performance of physical activity (PA) in school-age students has been associated with positive health outcomes (Janssen and LeBlanc, 2010). Schools are a prime setting for promoting and adhering to PA. Specifically, the Physical Education (PE) subject plays a key role by accepting this challenge as one of its main objectives. Among the many variables that evaluate PA levels, several studies have centred on ascertaining students' game performance (GP) (Harvey & Jarrett, 2014), paying special attention to the processes that impact the technical-tactical dimension of learning.

Instructional models (Metzler, 2017) are no strangers to these processes. The initiatives undertaken demonstrate their potential for technical-tactical development as well as their superiority over traditional teaching (*direct instruction*). The Sport Education Model (SEM, Siedentop, 1994) has also been explored in terms of GP. Several reviews (Hastie et al., 2011) underscore its potential in technical-tactical development. The review by Araujo et al. (2014) presents disparate results, explained, among other reasons, by the intervention times. Successive studies have sought to overcome these limitations. Thus, the longitudinal experience of Araujo et al. (2017), based on a hybrid proposal, reported improvements in pre-adolescents in GP.

Studies which have evaluated GP have considered gender (Hastie et al., 2009), skill level (Mahedero et al., 2015) or both conditions (Araujo et al., 2017) as independent variables. Mirroring the disparity found by Araujo et al. (2014), the results point to significant improvements in both low (Araujo et al., 2016) and moderate (Mahedero et al., 2015) ability level students. They also report positive effects on females (Mesquita et al., 2012) and males (Hastie et al., 2009). Gender is a variable of special importance in PE. For example, previous studies noted stereotyped participation, more pronounced in invasion sports, with women being relegated to the role of "spectators" (Gutiérrez & García-López, 2012).

Aside from these contributions, there are no SEM studies on GP that have considered students' nationality as a distinctive variable. Assessing the model's impact by cultural group might be an approach to the search for more equitable participation, which is recognised as one of the aims of the SEM (Siedentop, 1994) and has been a constant in studies on the SEM and GP (Araujo et al., 2017; Mahedero et al., 2015).

Nationality can be viewed dichotomously, with students belonging to the hegemonic group, described as *indigenous*, and on the other hand students with a different nationality from the hegemonic group, i.e., *immigrants*. Apart from any possible variation in this latter group, one extremely interesting shared aspect is the fact they have gone through a migratory process. The potential differences by nationality are especially appealing. Previous research found that motor skills varied by student nationality, not due to ethnicity or culture, but rather to the PE curriculum used in the country of origin (Contreras et al., 2007). As for the relationship between the model and interculturality, recent studies report significant improvements in the perceived competence of indigenous students without finding any impact on immigrants (Puente-Maxera et al., 2018). This evidence seems to suggest that it would be advisable to analyse GP by students' nationality.

The proposals implemented under the SEM (Hastie et al., 2011) have found invasion sports to be attractive content given their pre-eminence in the curricular framework. This type of sport stands out for its high degree of spontaneity and is characterised by a series of common tactical principles, including (Bayer, 1979) holding onto the ball and advancing towards the opposition goal.

Considering the population being studied, the bulk of the research included in the review by Araujo et al. (2014) was conducted in secondary education contexts (SEd, $n = 9$) and in the final stage of primary education (PEd, $n = 4$). Only one study (Calderón et al., 2010) involved students in the second stage (third year of PEd). The authors reported improvements in students' technique and game knowledge (GK). These data underscore the paucity of and the need for SEM studies which examine GP in first-stage PEd students (Layne & Hastie, 2016).

Accordingly, this study sought to analyse the prolonged effect of an SEM-based unit of teaching on the level of execution in attack (EX-A), decision-making (DM), and GK in a group of second-year PEd students. Additionally, it sought to ascertain the incidence of gender and nationality on the results obtained. It was hypothesised that the intervention would lead to significant improvements (a) in GP (EX-A and DM); and (b) in students' GK (rules), regardless of gender and nationality.

Methodology

Research design

This study adhered to a quasi-experimental design with pretest, posttest and retest measures. Studies with the SEM have followed these types of designs (Mesquita et al., 2012). Similarly, the research adopted a multimethod approach combining quantitative and qualitative instruments as in previous research (Mahedero et al., 2015). The fidelity of the implementation of the model was enhanced by Hastie and Casey's (2014) guidelines, which call for: a) a detailed description of the programme context; b) a detailed validation of model implementation; and c) an extensive description of the curricular elements of the unit.

Participants and context

Context. The intervention was carried out in a state co-educational PEd school in a town in southern Spain.

Students. The sample was selected following a non-probabilistic convenience model. It was comprised of a group of 34 students (22 boys and 12 girls) aged between seven and eight years ($M = 7.53$; $SD = .50$) and consisted of the combination of two previously formed groups in second year PEd. As for nationality, 11 students were indigenous (Spanish) and 23 immigrants. No student had had any experience with the SEM prior to this intervention. Similarly, they lacked experience of federation-registered invasion sports according to the data obtained through a sociogram featuring assorted questions administered at the beginning of the course.

Teachers. The teaching was undertaken by two specialist PE teachers with different levels of experience with the model (one expert with four years of using it and the other a beginner). Informed consent was obtained from the school administration, the PE department and the students' legal guardians. The study was approved by the ethics committee of the University of Oviedo.

Procedure

The programme was designed by the teacher who was an expert in the SEM with the assistance of their new colleague. The validity of the model was certified based on the instrument developed by Sinelnikov (2009, Spanish version by Calderón et al., 2010). Due to age and inexperience with the model, the following items were not considered: a) the teacher includes shared assessment as part of the data collection process, and b) the students participate in team selection.

A programme of 12 sessions (two per week) lasting 60 minutes was conducted to teach a pre-sport game as an introduction to handball called *the five passes*. The players were not allowed to bounce the ball or move when in possession of it, while they could move freely when not in possession. A competition schedule was drawn up to ensure the greatest possible equal participation. The season progressed through the following phases: (a) introductory, (b) directed, (c) autonomous practise, (d) formal competition and (e) final event. In terms of social organisation, the 34 students were divided into eight heterogeneous (gender, nationality) groups of four members (except for two teams of five students). The students took on roles other than that of player: coach, physical trainer, equipment manager and occupational health and safety officer.

Instruments

Systematic video monitoring. Two students were not evaluated because they changed schools before the start of the recording, resulting in a final sample of $n = 32$. A total of 12 recordings lasting 10 minutes each one documented the students' performance in 4 vs. 4 games. Two cameras (one in each half of the court) were placed in one of the corners of the court to cover the entire playing area. The recordings were made at three different times: before the start of the unit (pretest), after the end of the unit (posttest) and two weeks after the end of the unit (retest). A body expression unit of study was taught during the retention time.

Student interviews. After the intervention, interviews were conducted in groups of five to six students (Ennis & Chen, 2012). A total of eight semi-structured interviews were recorded in which respondents shared their knowledge of the programme implemented. The interview scripts were reviewed by four experts (two doctors and two teachers with at least 10 years of experience).

Teacher interviews. Semi-structured interviews (Cohen & Manion, 2002) were conducted individually with each of the participating teachers at three points: before, during (after the sixth session) and after the intervention. The interviews, which dealt with technical-tactical issues and methodological components, were recorded in audio files and later transcribed. They had an average length of approximately 10 minutes.

Teachers' diaries. Each of the participating teachers compiled their most significant observations in a diary. The instrument was structured by prioritising the following aspects: variables under study (EX-A, DM, etc.) and their relationship with the factors intrinsic to the SEM (e.g. roles).

Qualitative inter-evaluator evaluation. Following the guidelines of Hastie et al., (2013), inter-evaluator qualitative analyses were used. Three experts in the field (one PhD in PA science and two PE teachers) were asked to comment on the findings, identifying strengths and weaknesses with respect to the components under analysis.

Qualitative data analysis

Interviews and diaries. The diaries and interviews were analysed manually using inductive techniques and based on the summary, coding and comparison of participants' responses through information reduction and display processes. After several readings, the information was broken down into a number of ideas or perceptions which were then coded and classified into various categories. A further analysis led to the selection of two categories that seemed to summarise the information best: a) development of technical-tactical skills, and b) game knowledge.

Inter-evaluator analysis. The experts' evaluation generated a total of 191 comments, which were coded using previously established categories according to the variables under study (losing your marker) and other emerging variables (knowledge of the rules). Nineteen comments were grouped around a "neutral" category given their discrepancy with the rest of the categories. A frequency matrix determined the degree of significance of the categories and their interrelationship, resulting in the components shown in the qualitative results (Table 2).

Quantitative data analysis

Video recordings. The students' performance was evaluated using the Game Performance Assessment Instrument (GPAI, Oslin et al., 1998). Offensive ball actions (passing/receiving) loaded on the EX-A component, while non-ball actions (support/defence) loaded on DM. Two experts (PhDs in Physical Activity Sciences) were tasked with coding the actions. The criteria and descriptors were formulated and reformulated until the greatest consensus was reached among the experts. The quality of the components was evaluated in order to make them observable and measurable. The scoring system used was the record of events that rates each action dichotomously (effective/ineffective for executions; appropriate/inappropriate for decisions). This scoring system is recommended when observers evaluate actions by means of video recordings.

The resulting components and their descriptors were: (a) passing (effective: the ball reaches an unmarked teammate at an appropriate speed; ineffective: it goes too high, too far (backward or forward), or is intercepted by an opponent); (b) receiving (effective: the player catches the pass and takes possession of the ball; ineffective: the player fails to catch the pass); c) offensive support (appropriate: moving to a suitable position to receive a pass (finds a free space); inappropriate: (not in a suitable position to receive the ball; remains static), and (d) defence (appropriate: stands in the path between the ball and the attacker without the ball, remaining active; inappropriate: standing outside the path between the ball and the attacker without the ball, remaining static and/or not involved in the game). The rates of EX-A (effective executions/sum of effective and ineffective executions), DM (appropriate decisions/sum of appropriate and inappropriate decisions), GP [(E+D)/2] and game involvement (GI = sum of all actions taken by a subject) were derived.

Reliability

Following inter-evaluator processes, one evaluator (a PE teacher) not involved in the compilation process followed a 90-minute training session, successively viewing three different matches corresponding to the autonomous practise phase in order to code the actions based on the stipulated criteria. Discrepancies were resolved, and mainly concerned off-the-ball situations (offensive and defensive support). After this phase, the test-retest method was used after an interval of two weeks and under identical conditions. The intraclass correlation coefficient (ICC, Atkinson and Nevill, 1998) was calculated, yielding excellent values (ICC > .90) for all the variables analysed with the exception of EX-A in PosT (.69). Under these conditions, 818 decisions and 802 executions were analysed, which represented 40% of the total sample, far exceeding the 10% recommended by Tabachnick and Fidell (2007).

Statistical analysis

The IBM-SPSS statistical software (version 23.0) was used for the analysis of the information. Descriptive statistics (means and standard deviations) were calculated for each of the variables. Exploratory analysis revealed that the data distribution did not meet

the criteria of normality (Shapiro-Wilk test) and homogeneity of variance (Levene's test). Consequently, non-parametric tests were performed. Intragroup differences over time were calculated with the Wilcoxon signed-rank test for two related samples. Intergroup comparisons were made using the Mann-Whitney U-test for two independent samples (gender and nationality). In each case the value of statistical significance was set at $p < .05$.

Triangulation

In terms of methodological complementarity, the use of quantitative and qualitative instruments made it possible to gain a more accurate and holistic picture of the phenomenon under study, while also overcoming the limitations of the quantitative and qualitative paradigms when used in isolation.

Results

Quantitative results

Table 1 shows the results of each of the performance indexes evaluated. Intragroup comparisons reported significant PreT-ReT increases in the total sample in both DM ($Z = -2.294$; $p = .022$) and in GP ($Z = -2.254$; $p = .024$). In terms of student origin, improvements were observed in indigenous students in the PosT-ReT DM ($Z = -1.992$; $p = .046$) and in students from immigrant backgrounds in the PreT-PosT EX-A ($Z = -2.357$; $p = .018$), in DM PreT-PosT ($Z = -2.023$; $p = .043$) and PreT-ReT ($Z = -2.015$; $p = .044$), and in GP PreT-PosT ($Z = -2.171$; $p = .030$) and PreT-ReT ($Z = -2.486$; $p = .013$). No significant changes were found in terms of gender.

The analysis using the Mann-Whitney U test determined significant gender differences in DM PreT ($p = .006$), PosT ($p = .003$) and ReT ($p = .008$), in GP PreT ($p = .007$), PosT ($p = .013$) and ReT ($p = .014$) and in GI PreT ($p = .015$), PosT ($p = .011$) and ReT ($p = .045$). There were no significant differences by origin.

Qualitative results

Interviews and diaries. The qualitative information considering the two categories extracted from the analysis of the teaching diaries and the interviews with both teachers and students is set out below.

Technical-tactical dimension. With regard to the development of technical-tactical skills, the inexperienced teacher pointed out that most of the students started from a low level, although they noted that some students showed a good command of the basic requirements of pre-sport games. The first changes were reported by the new teacher after the fifth session: "Skills in passing and receiving are increasing and they are also beginning to master the tactics of the game". On a teaching level, the expert teacher attached special importance to real game situations as they are decisive for the students' learning. As a result of the intervention, both teachers reported an increase in motor skills: "The level of competence has risen very significantly"; "Competence has come on a lot, not only technically but also tactically". The expert teacher underscored changes in the participation of students with a low skill level ("normally static, in this type of game I see them as very participatory"), as well as in female students ("initially relegated to a secondary and less participatory role, they are now more prominent").

Game knowledge. Both teachers forecast that the students would gain a high level of knowledge of the game.

Table 1
Means (standard deviations) of game execution, decision-making, performance and involvement rates for the total sample, gender and origin

	Execution			Decision-making			Performance			Involvement		
	PreT	PosT	ReT	PreT	PosT	ReT	PreT	PosT	ReT	PreT	PosT	ReT
n	.69 (.18)	.78 (.15)	.75 (.12)	.50^{a} (.29)	.57^{ab} (.29)	.58^{b} (.28)	.59^{a} (.19)	.66^{ab} (.20)	.67^{b} (.14)	12.50 (5.71)	13.06 (7.65)	14.29 (7.53)
Males	.73 (.11)	.76 (.14)	.74 (.14)	.61 (.23)	.69 (.23)	.69 (.23)	.67 (.14)	.73 (.15)	.71 (.11)	14.40 (5.23)	15.65 (7.69)	16.20 (8.28)
Females	.62 (.26)	.82 (.16)	.76 (.08)	.30 (.27)	.36 (.27)	.40 (.26)	.46 (.21)	.55 (.23)	.58 (.14)	9.33 (5.21)	8.75 (5.48)	10.82 (4.40)
Indigenous	.73 (.17)	.72 (.16)	.69 (.14)	.60^{ab} (.30)	.59^{a} (.25)	.68^{b} (.24)	.66 (.21)	.66 (.15)	.68 (.10)	13.86 (6.04)	13.14 (4.67)	14.42 (4.64)
Immigrants	.68^{a} (.19)	.80^{b} (.15)	.77^{ab} (.11)	.47^{a} (.28)	.56^{b} (.30)	.56^{b} (.29)	.57^{a} (.19)	.66^{b} (.22)	.66^{b} (.15)	12.12 (5.68)	13.04 (8.37)	14.25 (8.27)

Note. In each row, the means with different superscripts differ at least to a level of $p < .05$.

Table 2
Results of the inter-evaluator qualitative analysis for each of the components analysed

		Example remark
Passing (11%)	PreT	• The passes are not that good and sometimes they "mess it up".
	PosT	• They get better over time, which you see in terms of the quantity and quality of the passes, which translates into a higher number of points.
	ReT	• They really throw it hard and are usually very successful.
Receiving (8.4%)	PreT	• At first, the team in possession of the ball is poor at both catching and implementing moves.
	PosT	• In this match, the players without the ball constantly ask for it from their teammates and make successful receptions.
	ReT	• They perform receptions successfully which results in high-quality play; active and effective.
Support (24%)	PreT	• They don't look for gaps or ask the player with the ball to pass properly, i.e. they don't usually say positions (pass over the top, low down, etc.).
	PosT	• As they get better, they move more off the ball both to lose their marker and score when they attack and to intercept the pass when they are defending.
	ReT	• In this game, players without the ball move very actively, constantly asking for the ball from their teammates.
Defensa (25.6%)	PreT	• At first, the most significant thing is that they crowd around the player who has the ball too much, pushing and constantly committing fouls.
	PosT	• Signs of defensive actions such as covering team members in possession of the ball are starting to emerge.
	ReT	• Not only do they move to look for the ball, but sometimes they take up very significant defensive positions.
Game knowledge (12.5%)	PreT	• At first, they don't seem to know the rules very well, as they continually walk around holding the ball when that's not allowed.
	PosT	• There has been obvious progress from the groups' first contact with the activity to an understanding of the rules and purpose of the game.
	ReT	• After some time, you can see that most of the contents worked on have been retained.

Note. In brackets, percentage of comments in relation to the total information.

They mentioned the kind of content: "We are talking about a fairly simple pre-sport game. They will have no difficulty in fully understanding the game in all its facets," said the new teacher. As the intervention moved forward, the expert teacher confirmed these predictions: "As a whole, the students have a good understanding of the game". They said that the theoretical session on refereeing was a crucial factor.

The students associated the knowledge acquired with the opportunity to perform various functions: "It is not only about playing, but also about refereeing and making notes". Several students acknowledged better use of time. When asked about their involvement and its comparison with previous units, most of the respondents stated that they had increased their levels of concentration in the game. The reasons given included the model's competition format. This is shown by the following comments: "There are points at stake"; "These games are more important"; "This is the league".

Inter-evaluator analysis

The results of the inter-evaluator qualitative analysis are shown in Table 2, in which representative comments about the components analysed at each of the data gathering stages are presented.

Discussion

This study set out to examine the evolution of game performance and game knowledge of second-year primary school students participating in an SEM season on introduction to invasion sports. Specifically, the effects were analysed by the gender and nationality of the participating students. In general, the results confirm the hypotheses proposed, particularly improvements in general performance, decision-making and game knowledge. Changes of special significance by nationality were also observed, albeit not accompanied by effects in relation to gender.

The progress in overall performance and decision-making of the total sample are in line with the conclusions reported by Mesquita et al. (2012), who found greater gains in the retention phase. The results of this study seem to point to short-term improvements and call for further longitudinal experimentation. However, the slight differences in posttest-retest values in both dimensions seem to suggest the intervention had a maintenance

effect, similar to the one reported in previous studies on the SEM (Araujo et al., 2016). With respect to DM, and in line with the findings of this study from a qualitative perspective, Mesquita et al. (2012) noted the positive effect of learning in real game situations. One distinctive aspect in this study was the notable improvements in offensive DM, which was rarely observed by Mesquita et al. (2012), who cited lack of precision in teacher planning.

The largest number of changes was observed in relation to nationality, with students of immigrant origin being the only group to experience technical improvements. From the qualitative point of view, substantive changes were found in various aspects of execution (precision or variety of throws). The teachers pointed out the constructive impact of the content worked on, especially in relation to technical requirements. These findings are consistent with Hastie et al. (2009), who associated the approach of low technical requirement content (handball games) with higher probabilities of success in SEM seasons. The content was appropriate not only in execution but also in tactical development. Mesquita et al. (2012) pointed out the positive impact of the forms played on DM, which are equally germane in talent identification (Serra-Olivares et al., 2017). Improvements in dynamism and spatial distribution were particularly significant, the latter having been reported previously (Mahedero et al., 2015). Several reasons seem to account for these changes. First, the number of sessions performed, with the first changes observed towards the middle of the season, reflects the positive impact of programming long-term units. Second, the competition format itself, with a large number of matches (Hastie et al., 2009), was cited by students as a key factor in tactical learning and GK. In relation to the latter variable, the positive effect of performing roles other than players was evident for many students. Hastie et al. (2009) found that when students acted as "active observers" their DM and GK improved.

Finally, no significant changes were found in relation to gender, contrary to what had been suggested by the literature (Araujo et al., 2014). Given the high starting values in terms of execution, the absence of improvement in male students could be explained by a "ceiling effect", something which has been previously observed (Mesquita et al., 2012). Although they are not analysed in this study, qualitative improvements were found in students with low skill levels. Future interventions should consider skill level, along with other independent variables included in this study (nationality) and explore their impact on GP in young students.

Conclusions

The results of this study would seem to confirm the potential of the SEM with respect to an introduction to invasion sports, meaning that its benefits can be extrapolated for the first time to contexts of high cultural diversity and with young students. The improvements in game performance are particularly relevant given the age of the students and their lack of experience with the SEM, suggesting that the version of the model applied was extremely successful. Moreover, the impact generated in both cultural groups (indigenous and immigrants) suggests that the intervention included teaching elements (roles) consistent with the principles of fairness.

However, a number of limitations should be considered. The fact that the intervention targeted a single group and school and was taught by teachers with varying degrees of experience makes it difficult to generalise. Similarly, the duration of the intervention was not consistent with the time recommended by the literature (more than 15 sessions, according to Siedentop, 1994). The sample size of certain group conditions (women or indigenous people) might explain the low impact. Future interventions should consider larger samples.

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Perceived Effort, Satisfaction and Performance Times during a Mime and Drama Unit of Study

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New Olympic Sports for Tokyo 2020: Karate. Photo: Haifa, Israel - July 11, 2017: The Karate competitions during 20th Maccabiah Games at the Romema Arena.

Abstract

The objectives of this study were to describe, taking student age into account, the perceived effort, satisfaction, useful time and available time in a mime and drama unit of study in primary education students and also to analyse intersession variability and the association between the different variables. The results of this paper show that students experience a low perceived effort (2.48±2.33 out of 10) but high satisfaction (3.52±2.68 on a -5 to +5-point scale) during mime and drama sessions in the body expression block. Moreover, of the 90 minutes of weekly physical education included in the official syllabus, the average useful time per session was 53.22±10.52 min per week (58% of total time), of which only 27.06±6.97 min (30% of total time) corresponded to the time available, which is far from the recommendations on school-age physical activity.

Keywords: physical education, curriculum, teaching, study, body language

Introduction

In the official primary education curriculum, physical education (PE) content is divided into separate blocks which support overall student development (LOMCE, 2013). However, although the official curriculum stipulates that all blocks are important, previous studies have shown that in primary education (PEd), the body expression (BE) block is the one that enjoys least time in PE programmes (Coterón & Sánchez, 2012) and the one that is rated lowest by teachers (Archilla & Pérez, 2012). However, since BE promotes body awareness, it renders it possible to achieve progressive sensitisation from the motor and expressive standpoint while also facilitating the development of creativity (Loveless et al., 2005), it is important that sufficient time be dedicated when this content block is programmed (Archilla & Pérez, 2012). This block covers contents intended to promote communication and expressiveness through the body and movement, such as dance, rhythm, imitation, mime and drama (LOMCE, 2013).

In order to learn about the features of BE-content units of study, more specifically the ones based on mime and drama, they may need to be analysed from a variety of standpoints. Firstly, the overall intensity of PE sessions has been measured by means of rating of perceived effort (RPE) scales, known to be a simple and useful instrument for quantifying effort in PE sessions (Kang et al., 2003). The OMNI perceived effort scale is frequently used in PEd as it was developed for use with children and has shown a high correlation with objective variables (Kang et al., 2003; Robertson, 2004). Using this scale, previous studies have measured the perceived effort of PEd students during a range of activities in PE sessions (Bendiksen et al., 2014), concluding that BE is the content in which the lowest perceived effort is observed (Hernández-Álvarez et al., 2010). From another standpoint, another factor that has featured heavily in research is the study of student emotions and satisfaction in PE sessions. Student satisfaction can be evaluated in a number of ways (Ekkekakis, 2012); one of the most widespread methods is the Feeling Scale (FS) (Hardy & Rejeski, 1989), which measures emotional response to an activity through the subjective experience of a positive or negative feeling (Schneider & Kwan, 2013). The affective experience or satisfaction depends on a number of variables, particularly the type of activity performed (Wei et al., 2006).

It may be important to ascertain PEd students' satisfaction with BE, since a high degree of satisfaction is related to greater adherence to physical activity (Kwan & Bryan, 2010), greater motivation for physical exercise (Focht, 2009), more fun during the session and long-term learning retention (Parfitt et al., 2006). Although students mainly experience positive emotions during BE activities (Torrents et al., 2011), they have been shown to attach scant value to BE content (Moreno & Hellín, 2007). Equally, it is unknown whether perceived effort and satisfaction in BE sessions varies by age or school year, so further studies examining these aspects in PEd students are called for.

Another significant aspect to be considered when different units of study are implemented from different content blocks may be the time allocated to them (Olmedo, 2000). Previous studies have shown that programme time, i.e. the time officially allocated to PE in school timetables, does not match the useful time or the time available for performance (Hernández-Álvarez et al., 2010; Olmedo, 2000) which depends on aspects such as the type of sessions proposed (Calderón & Palao, 2005) and the motivational climate (Silverman, 2005). It is crucial that useful time and time available in BE sessions be as long as possible, since students who spend more time engaging in good practices tend to learn more (Rink, 2003). Although it is important to know both the time available for performance and the useful time when conducting BE units of study, no scientific research which examines these variables in BE sessions in the primary education stage has been found.

Accordingly, the objectives of this study were 1) to describe, according to school year, the perceived effort, satisfaction, useful time and time available in a unit of study in body expression based on mime and drama in primary education students, and 2) to analyse intersession variability and the association between the different variables.

Methodology

Participants

This study used a convenience sample and involved 131 students in PEd Years 1-6 at a state school, 66 of whom were girls and 65 boys.

The total sample was divided into six groups by the students' school year, called first year (G1, $n = 20$), second year (G2, $n = 24$), third year (G3, $n = 21$), fourth year (G4, $n = 21$), fifth year (G5, $n = 22$) and sixth year (G6, $n = 23$) of primary education. Table 1 presents the age, weight, height and body mass index (BMI) of all the participants and of each one of the groups. Before the research began, the procedures,

Table 1
Student characteristics

	Age (years)	Weight (kg)	Height (m)	BMI (kg·m^{-2})
All	8.56±1.76	33.48±10.31	1.34±0.10	18.15±3.37
G1	6.05±0.21	23.78±5.00	1.19±0.05	16.54±2.62
G2	7.08±0.27	26.45±5.58	1.27±0.04	16.12±2.74
G3	8.05±0.21	33.20±8.39	1.31±0.06	18.86±3.06
G4	9.14±0.35	37.14±8.46	1.39±0.07	18.83±2.64
G5	10.05±0.22	40.97±12.04	1.42±0.05	19.87±4.39
G6	11.13±0.34	40.28±8.01	1.45±0.05	19.06±3.21

Note. G1-6: group based on school year.

Table 2
Activities performed in each session

Session	Activities performed
1	Imitation activities in pairs and small groups.
2	Imitation activities in small and large groups.
3	Individual mime games in small groups.
4	Individual mime games in small and large groups.
5	Individual mime games in large groups and with props.
6	Drama: improvisation.
7	Drama: theatre.
8	Drama: theatre and scenario building.

methodology, benefits and possible risks of the study were explained to the participants and all the parents or legal guardians signed the informed consent form. The study followed the guidelines set out in the Declaration of Helsinki (World Medical Association, 2013) and was approved by the Ethics Committee for Research with Human Subjects (CEISH code 2015/147) of the University of the Basque Country.

Procedure

Between January and March 2016, a unit of study on body expression based on mime and drama was held over eight consecutive weeks in the PE sessions. The students had a weekly PE session lasting 90 minutes, which was taught by the school's PE teacher. In all the sessions, the perceived effort and perceived satisfaction of the students who were familiar with the use of both scales were measured, and at the end of each session they were given a sheet of paper on which they had to mark their perceived effort and their overall satisfaction with the session individually. Two expert researchers attended each session and recorded the useful time and the time available for performance by observing the session directly and using a stopwatch.

Rating of Perceived Effort (RPE). The rating of perceived effort was evaluated using the OMNI scale for girls and boys (Robertson et al., 2000) which has a range of 0-10 and is aided by visual and verbal descriptors (Robertson, 2004). The OMNI scale had been validated for use with students aged 6-15.

Satisfaction. The satisfaction perceived by the students in each one of the body expression sessions was measured by the Feeling Scale (FS) (Hardy & Rejeski, 1989). Students evaluated their satisfaction on an 11-point bipolar scale from -5 (very bad) to +5 (very good). The FS had been validated for use in the context of physical activity.

Useful time, time available and useful time/time available ratio. In order to record the useful time (min), the time from the moment the student left the changing room until the moment they entered it again was accounted for (Olmedo, 2000), namely the total time the students were on the court where the PE session took place. To record the time available (min), only the time during which students could perform motor actions in the PE sessions was counted. In this case, the time during which students were in the changing room, the time taken up by explanations by the teachers and all kinds of interruptions during the sessions were excluded (Olmedo, 2000). Finally, the useful time/time available ratio was calculated by dividing the minutes of useful time recorded by the minutes of time available recorded in each one of the sessions.

Intervention programme. The programme lasted eight weeks, with one weekly 90-minute session per group. All the sessions started with a standard 10-minute warm-up consisting of an initial general muscle activation phase and a second more specific phase for BE content. In the main part of the session, students performed age-appropriate body expression activities such as mime, peer imitation or theatre tasks (Table 2).

Statistical Analysis

The results are presented as mean ± standard deviation (SD) of the mean. The intersession coefficient of variation (CV) (CV = SD/Mean) was calculated for each one of the variables analysed for all students and for each age group (G1-G6). One-factor ANOVA with post hoc Bonferroni correction was used to analyse the differences between the age groups in the variables. In addition, the Pearson correlation coefficient (r) was calculated to determine the associations between the results obtained in perceived effort, satisfaction, useful time,

Table 3
Perceived effort, satisfaction, useful time, time available and the useful time/time available ratio for each age group

	G1	G2	G3	G4	G5	G6	Diff. between groups
Perceived effort	3.08 ± 2.46	2.91 ± 2.19	4.15 ± 3.19	1.77 ± 1.42	1.45 ± 1.82	1.17 ± 1.31	G1 and G2**, G3**, G4**, G5**, G6** G2 and G3**, G4**, G5**, G6** G3 and G4**, G5**, G6**
Satisfaction	3.57 ± 2.90	4.00 ± 2.28	2.86 ± 3.32	3.20 ± 2.80	2.78 ± 3.27	3.98 ± 1.33	G2 and G3*, G5* G5 and G6*
Useful time (min/session)	57.33 ± 0.47	49.11 ± 17.16	54.03 ± 7.23	49.06 ± 6.38	50.06 ± 13.33	57.50 ± 3.37	G1 and G2**, G4**, G5** G2 and G6** G4 and G6** G5 and G6**
Time available (min/session)	26.55 ± 4.02	21.36 ± 6.37	25.25 ± 3.48	21.38 ± 13.35	33.06 ± 5.30	35.02 ± 2.48	G1 and G2**, G4**, G5**, G6** G2 and G3**, G5**, G6** G3 and G4**, G5**, G6** G4 and G5**, G6**
Useful time/time available ratio	2.21 ± 0.36	2.25 ± 0.39	2.13 ± 0.12	2.20 ± 0.18	1.49 ± 0.25	1.62 ± 0.13	G1 and G5**, G6** G2 and G5**, G6** G3 and G5**, G6**, G4 and G5**, G6**

Note. G1-6: group based on school year.
*p<.05; **p<.01, significant differences between years.

time available and the useful time/time available ratio. The following scale was used to interpret the magnitudes of the correlations: <0.1, trivial; 0.1 to 0.3, small; 0.3 to 0.5, moderate; 0.5 to 0.7, large; 0.7 to 0.9, very large; >0.9, almost perfect (Hopkins et al., 2009). The statistical analysis was performed with the Statistical Package for Social Sciences (SPSS Inc., version 22.0, Chicago, IL, USA). The statistical significance was $p < .05$.

Results

The result achieved by all the students during the body expression sessions, specifically mime and drama, was 2.48 ± 2.33 for perceived effort and 3.52 ± 2.68 for satisfaction. As for times, the mean per session of useful time for all students was 53.22 ± 10.52 min, the mean per session of time available was 27.06 ± 6.97 min, and the mean of the useful time/time available ratio was 1.99 ± 0.43. Table 3 presents the results for perceived effort, satisfaction, time available, useful time and the useful time/time available ratio recorded during the sessions for each age group, as well as the differences between the age groups. Differences were observed between the age groups in perceived effort, satisfaction, time available, useful time and the useful time/time available ratio.

Table 4 shows the results of the intersession CV for perceived effort, satisfaction, time available and useful time for all students and for each age group.

Finally, significant correlations were found between age and perceived effort ($r = -.31$, moderate, $p < .01$), age and useful time ($r = .52$, large, $p < .01$), and between time available and useful time ($r = .60$, large, $p < .01$).

Discussion

The main objective of this study was to describe, according to school year, perceived effort, satisfaction, useful time and time available when performing a unit of study in body expression based on mime and drama

Table 4
Intersession coefficient of variation (CV) for all students and for each age group

	Todos	G1	G2	G3	G4	G5	G6
Perceived effort (%)	0.28	0.23	0.12	0.32	0.61	0.95	0.18
Satisfaction (%)	0.09	0.14	0.15	0.20	0.20	0.58	0.10
Time available (%)	0.15	0.01	0.42	0.24	0.14	0.32	0.05
Useful time (%)	0.10	0.17	0.36	0.22	0.20	0.18	0.38
Time available/useful time ratio (%)	0.09	0.19	0.21	0.05	0.09	0.20	0.09

Note. G1-6: group based on school year.

in PEd students. Another objective was to analyse intersession variability and the association between the different variables. The main contribution of this study is the analysis of BE sessions from a number of perspectives (perceived effort, satisfaction, useful time and time available), since most of the papers that have already examined BE in PEd are restricted to the analysis of a single aspect. Furthermore, this paper includes the analysis of the differences in the variables mentioned according to the students' school year.

The results of this paper show a low perceived effort (2.48 out of 10) for all the students in BE sessions in PEd. These results are consistent with those reported in previous studies (Hernández-Álvarez et al., 2010). In addition, significant differences were found among the different age groups with a higher perceived effort in the first three years of PEd than in the later years. By contrast, in this study students experienced great satisfaction in the sessions, with second- and sixth-year PEd students showing the highest rates. Although scant value is attached to BE by secondary education students in (Moreno & Hellín, 2007), the results achieved with PEd students are in line with those reported by Torrents et al. (2011), who concluded that students mostly experience positive emotions during BE activities. These results might suggest that mime and drama contents in BE do not involve a significant physical effort for PEd students, although satisfaction with this type of unit of study is high.

Furthermore, the results of this study show that of the 90 minutes of PE per week provided for in the programme, the mean useful time per session for all students was 53 min (58% of the total time), possibly due to the time taken to get to the sports hall and time spent in the changing room. Moreover, only 27 min (30% of the total time) corresponded to time available, figures which are far from the recommendations on school-age physical activity proposed by several studies (Pate et al., 2006). These data are similar to results reported in other research with PEd students involving BE (Hernández-Álvarez et al., 2010) or other PE content (Yanci et al., 2016). In addition, in this study significant differences were found in times by school year, where greater time available and higher ratios of useful time/time available per session were observed in fifth- and sixth-year PEd. Accordingly, PE teachers should consider increasing both useful time and time available when implementing mime and drama units of study, particularly in early PEd years, in order to give students more performance time.

The results of this study show that the intersession variation (CV) for both perceived effort and satisfaction and for useful time and time available was particularly small ($<.95$). These results reflect the minimal intersession variation in the variables analysed. Perceived effort, satisfaction, useful time and time available are apparently very similar in BE sessions, even when different tasks are used in each one or they are conducted on different days or in different weeks. CV results may be influenced by the way the teachers give their lessons. It is likely that when they work on a unit of study, the methodological strategies used and the type of organisation of the sessions have similar traits. It might be worthwhile for PE teachers to change their teaching methodology in the different sessions, even if the block of contents is the same, in order to change the perceived effort, satisfaction and useful time and time available of the students during their sessions.

Finally, the results of this study show a significant correlation between age and perceived effort, age and useful time, and between time available and useful time. As the students' age increases, the values for perceived effort in BE sessions fall. This may be because older students are able to focus on the pure BE task, while younger students have more active classes and also because the same intensity may be higher for them. Similarly, useful time is longer in the groups of older students. This might be because older students need less time to get to the sports centre and get ready for the session than younger students. These data are consistent with previous studies, which found that student characteristics may influence the degree of performance in PE sessions (Hastie et al., 2011). Consequently, in order to increase the time available for younger students as well, PE teachers should consider specific actions that would allow them to increase and optimise useful time and time available, especially in younger years.

Conclusions

The effort perceived by PEd students in mime and drama sessions in BE during this research was low, particularly from third year onwards, which suggests that the sessions on this content at this school do not involve major physical exertion. However, despite this low physical effort, it should be noted that PEd students experience great satisfaction during mime and drama sessions in BE. However, in view of the useful time and time available results achieved in the sessions analysed, they seem to be a long way from the recommendations on school-age physical activity, having 30% of time available compared to the time scheduled in the school syllabus.

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Relationship Between Jump Capacity and Performance in BMX Cycling

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Abstract

The objective of this study is to assess the relationship between the results obtained on different vertical jump tests and the top score recorded during a BMX (Bicycle Moto-Cross) test and the rider's performance. To do so, 10 BMX pilots participated in this study; 5 regarded as the élite group (EG) (age: 18.8±3.7, weight: 68.4±8.5 kg, height: 174±9 cm and previous BMX experience: 8±3.8 years) and 5 regarded as the recreational group (RG) (age: 19.8±4.8, weight: 69.2±11.7 kg, height: 170±9 cm, previous BMX experience: 4.2±1.3 years). Vertical jump capacity was obtained using the Bosco protocol, i.e. vertical squat jump (SJ), vertical countermovement jump (CMJ), drop jump (DJ) and repetitive jump (RJ), and time in race in a BMX circuit was determined. The results indicate a direct relationship between the time used to complete the circuit and the height of the jump reached in SJ (r: –.801; p: .017), CMJ (r: –.798; p: .018) and DJ (r: –.782; p: .022). This all suggests that assessing jump capacity using the Bosco test may be a useful tool for assessing BMX performance.

Keywords: BMX, jump test, performance, cycling, force

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New Olympic Sports for Tokyo 2020: Karate. Photo: Haifa, Israel - July 11, 2017: The Karate competitions during 20th Maccabiah Games at the Romema Arena.

Introduction

Bicycle Motor-Cross (BMX), an Olympic sport since Beijing 2008, is a sports speciality in which a group of eight *riders* compete against each other in a circuit of variable length (200-400 m). The first rider to cross the finish line wins the race or the heat (Rylands et al., 2013). The competitions consist of four classifying heats in which the four fastest riders qualify for the next race, with this competition format producing the final race with the best riders from the four previous rounds. The recovery period between heats is 30 minutes, as established by the rules (Mateo et al., 2011).

Based on the length of the competitions, between 30 and 45 seconds, and the type of force made, maximum intensity, BMX is considered an endurance sport with explosive strength (Zabala et al., 2009). The characteristics of the courses and their layout on a slope mean that the capacity to accelerate on the bicycle, which requires high levels of strength, is essential in the first few metres of the race (Cowell et al., 2012; Mateo et al., 2011) and that the technical complexity to adapt to each part of the circuit is very high (Cowell et al., 2012). On the other hand, it has been suggested that the initial acceleration reached by the rider has a huge impact on the outcome of the competition (Herman et al., 2009). This would all seem to indicate that the metabolic demands are oriented towards anaerobic glycolysis and phosphagens (Zabala et al., 2008), with lactic acid concentrations of the blood recorded at around 8 mmol/l on average, with maximum values of 18.6 mmol/l (Louis et al., 2013; Zabala et al., 2009). Furthermore, anaerobic glycolysis plays a crucial role in the need to repeat high-intensity efforts both in the same heat and between heats, vastly determining the rider's recovery capacity (Louis et al., 2013).

Similarly, in this individual sport, individualisation of the training load is essential in monitoring fatigue, controlling adaptations and optimising performance (Capostagno et al., 2014). To do so, periodic physical assessments can determine the athlete's fitness and minimise the risk of injury (Lamberts et al., 2010). The selection of a battery of tests to assess different performance parameters is essential and depends on a range of factors, such as the duration of the effort to be analysed, the intensity at which this sports speciality is performed, the type of muscles involved in the movement patterns and the time in the season when they are done.

In this regard, a variety of tests have been used to assess BMX performance, both in the lab and on the competition circuit. Of them, the assessment of jump capacity stands out on account of its high reliability, specificity and low cost, and it is used as a way of assessing rider performance at different competitive levels (professional and amateur (Babault et al., 2018) and in new riders (Ramírez-Vélez et al., 2017) or masters (Del Vecchio et al., 2017). Although the use of jump tests as a methodology to evaluate the performance of BMX riders is widely accepted (Bertucci & Hourde, 2011), the level of association between these tests and competition performance has been viewed differently depending on the type of test, the distance ridden and the athlete's level. For example, Babault et al. (2018) found no correlations between the maximum height reached in a vertical countermovement jump (CMJ) and the amount of time taken to complete a timed circuit (r: –.25; p: .55), while Paquet et al. (2006) found that the maximum power generated in a jump test could explain 60% of the mean power generated in the Wingate test. Despite these results, there are no studies which have analysed the relationships between the results in different kinds of jumps and the best score recorded in a circuit.

For all these reasons, the main objective of this study is to assess the degree of association between the results in different kinds of vertical jumps and the best score recorded during a BMX race according to the type of rider.

Methodology

Participants

A total of 10 BMX pilots participated in this study; 5 regarded as the élite group (EG) (age: 18.8 ± 3.7, weight: 68.4 ± 8.5 kg, height: 174 ± 9 cm and previous BMX experience: 8 ± 3.7 years) and 5 regarded as the recreational group (RG) (age: 19.8 ± 4.8 years, weight: 69.2 ± 11.7 kg, height: 170 ± 9 cm and previous BMX experience: 4.2 ± 1.3 years) (Table 1).

The inclusion criteria for assembling the sample were: 1) for the EG: 1.a) be in the top 20 in the 2018 world ranking (published by the International Cycling Federation); 1.b) not have had an injury in the previous six months that could affect data collection; 1.c) have at least two years' experience of strength work under the supervision of a physical trainer. 2) For the RG, the inclusion criteria were: 2.a) have competed in at least three national races in the current year, 2.b) not have had an injury in the previous six months that could affect data collection; 2.c) have done strength work independently in the previous year. The exclusion criteria for both groups were: A) have had surgery in

Table 1
Descriptive characteristics of the study participants

	Total sample (*n*: 10)	RG (*n*: 5)	EG (*n*: 5)
Age (years)	19.75 (4.27)	19.75 (5.5)	19.75 (3.5)
Weight (kg)	69.75 (10.69)	70.25 (13.23)	69.25 (9.54)
Height (cm)	174.25 (8.21)	170.5 (10.41)	178 (3.37)
BMX experience (years)	7 (3.85)	4 (1.41)	10 (2.94)

the 12 months prior to the tests, and B) have any pain in the lower extremities or the trunk at the time of the study.

All the participants were informed of the objectives of this study verbally and in writing, as well as about the data collection procedures, in addition to the benefits and possible risks stemming from their participation. This study was designed following the ethical recommendations made by Harriss and Atkinson (2015) and in accordance with the latest version of the Helsinki Declaration (World Medical Association, 2013). The study protocol was approved by the Ethics Committee of Aragon (ref. no. 07/2019).

Experimental process

The data were collected in two different recording sessions with at least 48 hours between them, and blindly by a researcher who did not know the participants beforehand, and none of whom had made a maximum effort in the 24 hours prior to the tests.

In the first session, the participants completed an individual questionnaire which collected personal information on the number of years they had been participating in BMX, any injuries they had had in the past and their competition results. The participants were weighed on a scale and their height was measured with a height rod by the SECA© brand (1-mm precision for height and 0.1 kg for weight). Subsequently, they all engaged in a standard warm-up consisting in pedalling on a cycloergometer for 10 minutes at 50 rpm and an intensity of between 50%-63% of maximum heart rate (McGowan et al., 2015; Yang et al., 2017). The vertical jump protocol described by Bosco et al. (1983) was then administered; it consists of 3 repetitions for each of the tests: SJ, CMJ and DJ (from a height of 40 cm) and one for the repetitive jump test (RJ) for 30 seconds. The recovery between each of the repetitions of each test and between the different tests was 3 and 5 minutes, respectively. Furthermore, the mean height of the 3 attempts (SJ, CMJ and DJ) was determined. To calculate the Fatigue Index (FI), the mean of the first four jumps (Hmean_4) and last four jumps (Hmean_end4j) in the RJ test were obtained and the following equation was applied:

$$FI:[(Hmean\_4- Hmean\_end4j)/ Hmean\_4]*100$$

(Čular et al., 2018).

The Elasticity Index (EI) was calculated using the following equation:

$$EI:[(CMJ\ jump\ height - SJ\ jump\ height)]*100$$

(Bosco et al., 1983).

All the participants were verbally encouraged with the intention of producing their best result, and the different kinds of jumps were randomised with the exception of the RJ, which was executed last in order to prevent cumulative fatigue from influencing the other variables.

In the second assessment session, the best score on the BMX circuit at the Bike Park of Vila-sana in Lleida (E) (Figure 1) was recorded. This circuit is 400 metres long with an 8-metre starting ramp, and it was officially approved by the International Cycling Union (UCI) in 2009. All the participants were familiar with the route and had already trained or competed on it several times. A warm-up was done before the race times were taken, consisting of pedalling for 5 minutes on the circuit at a pace of 50%-60% of maximum perceived intensity. Afterwards, 2 complete circuits were done at an intensity of 80%-90% of maximum perceived intensity. A recovery time of 5 minutes between the warm-up sets was given, and the in-race time at 100% was subsequently recorded for each rider individually. Before the assessments, all the participants were asked not to eat or drink anything 90 minutes prior to the start of the test. No physical exertion was allowed in the 24 hours before the data were collected.

Figure 1
Circuit used to assess competition scores

Data collection

To assess the amount of time taken for the test, 2 electric eyes by the ARTEK® PNP brand (Proyectos de Iluminación Técnica Avanzada, SL, Spain) were used (response time <0.5 ms at 1 kHz), which were installed at the circuit's start and finish line. In order to avoid unintentionally activating them, the height of the first electric eye (starting line) was adjusted to be activated once the start gate opened, while the second electric eye was placed at the height of the axis of rotation of the front wheel. The entire closed measurement system was synchronised using a Voice Box System time control system and starting lights by the Daktronics® brand (Zabala et al., 2009).

Jump capacity was assessed using a contact platform by the Chronojump Boscosystem® brand (29.6 x 21 cm), connected serially to a Chronopic electronic microcontroller. The data were collected on the Chronojump 1.8.1 software. Both tools had previously been validated by De Blas et al. (2012).

Statistical analysis

First of all, the assumptions of normality were verified by plotting histograms and by means of the Shapiro-Wilks test. The mean, standard deviation and range [min.–max.] were then calculated for each of the variables analysed. The prediction intervals were calculated with a confidence of 95% and the differences between groups were evaluated using the t-test comparison of simple measures. The correlations between each rider's score and the value obtained in each of the jump tests were calculated with the Pearson correlation coefficient. In all tests, results were considered statistically significant when $p < .05$. All the analyses were performed in R (R Development Core Team, 2008).

Results

No significant differences were found between the participants' age, weight or height. However, the number of years of previous BMX experience was significantly lower in the RG compared to the EG (95% CI : [–10.41, –1.59]; $t(4)$: –3.67; p: .019).

With regard to the different kinds of jumps, the RG reached significantly lower heights than the EG with a difference of 95% CI: [-31.83, –0.84] cm ($t(6)$: –2.6; p: .042) in the SJ. Similarly, the CMJ was significantly lower in the RG (95% CI: [–32.65, –0.90] cm; $t(6)$: –2.6; p: .041), while race time for the was RG longer, that is, more seconds (95% CI: [10.39, 17.65]; $t(6)$: 9.52; $p < .001$). Furthermore, no significant differences were found between groups for the DJ ($t(6)$: 9.52; p: .06), Fatigue Index in the RJ ($t(4)$: 1.04; p: .364) and Elasticity Index ($t(4)$: 0.20; p: .852) variables. A comparison of the different values analysed can be found in Table 2 and Figure 2.

The relationship between the different jump variables, the race times and rider level are described in Table 3. The race time correlated negatively with the values obtained in the SJ ($R^2_{Adjusted}$: 0.58; $F(1.6)$: 10.76; p: .017), the CMJ ($R^2_{Adjusted}$: 0.58; $F(1.6)$: 10.52. p: .018) and the DJ ($R^2_{Adjusted}$: 0.55. $F(1.6)$: 9.44; p: .022). Conversely, no jump test showed a significant interaction between rider levels (RG or EG). Furthermore, neither the FI or EI showed significant associations with either race time or rider level.

Table 2
Comparison between groups for the different analysis variables

	RG	EG	Δ 95% CI	*t (df)*	*p*
Age (years)	19.75 (5.5)	19.75 (3.5)	[–8.3. 8.3]	0(5)	1
Weight (kg)	70.25 (13.23)	69.25 (9.54)	[–19.44. 21.44]	0.12(6)	.907
Height (cm)	170.5 (10.41)	178 (3.37)	[–0.23. 0.08]	–1.37(4)	.249
BMX experience (years)	4 (1.41)	10 (2.94)	[–10.41. –1.59]	–3.67(4)	.019*
SJ (cm)	32.4 (8.1)	48.7 (9.6)	[–31.83. –0.84]	–2.6(6)	.042*
CMJ (cm)	34.1 (8.5)	50.9 (9.7)	[–32.65. –0.90]	–2.6(6)	.041*
DJ (cm)	34.9 (8.7)	48.6 (8.2)	[–28.33. 0.80]	9.52(6)	.06
FI (%)	100.36 (27.56)	85.35 (8.89)	[–26.93. 56.93]	1.04(4)	.364
EI (%)	5.27 (7.04)	4.54 (1.52)	[–26.93. 56.93]	0.20(3)	.852
RT (s)	75.07 (1.89)	61.05 (2.26)	[10.39. 17.65]	9.52(6)	.000**

Figure 2
Graphic comparison between the groups for the variables related to the assessment protocol used

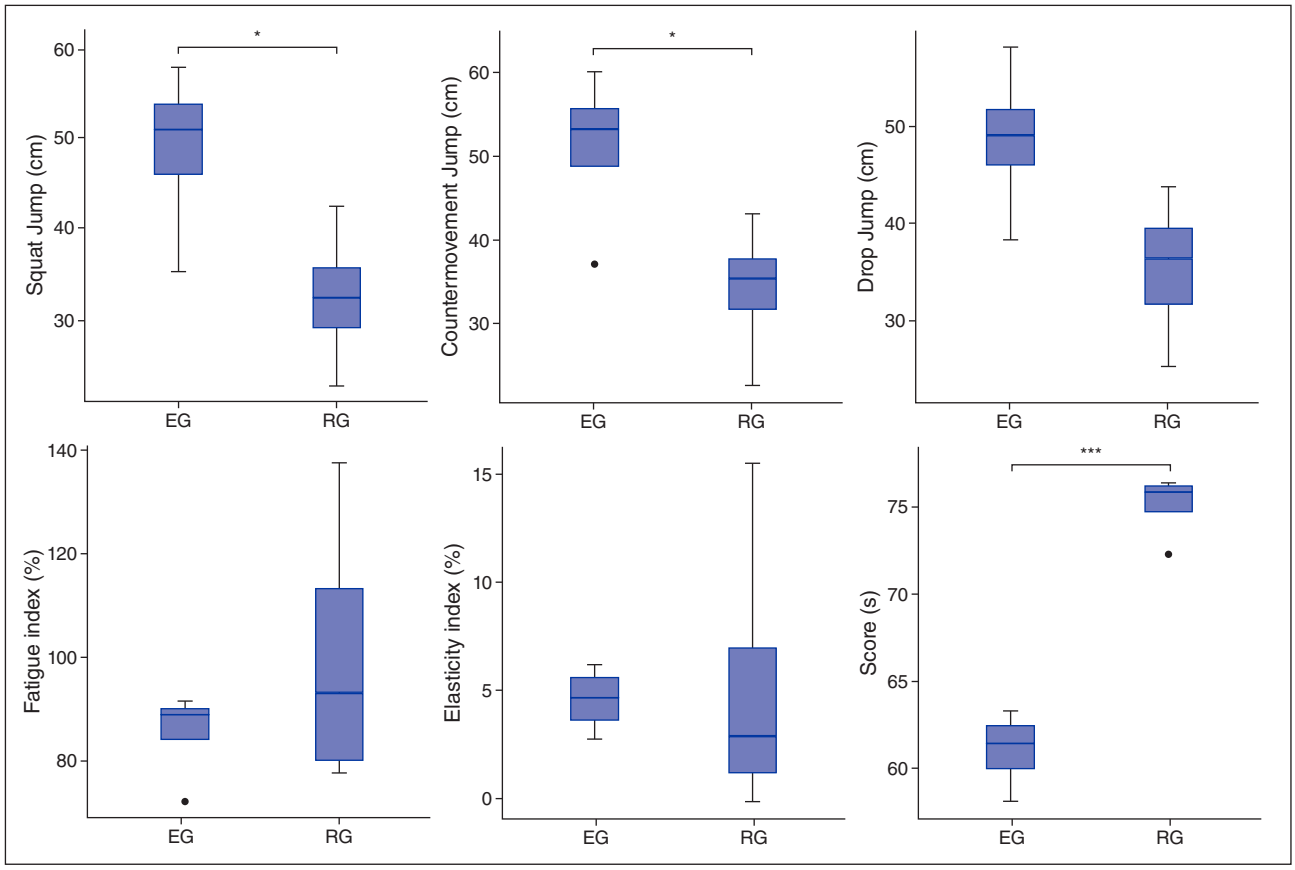

Table 3
Correlation table between race time, jump test and group

	Race time				Race time × Group		
	r_{xy}	*Adj* R^2	$F_{(1, 6)}$	*p*	*Adj* R^2	$F_{(2, 5)}$	*p*
SJ (cm)	–0.801	0.582	10.76	.017*	0.563	5.51	.054
CMJ (cm)	–0.798	0.576	10.52	.018*	0.55	5.29	.059
DJ (cm)	–0.782	0.547	9.44	.022*	0.579	5.81	.05
FI (%)	0.305	0.058	0.61	.463	0.08	0.74	.522
EI (%)	0.118	0.15	0.09	.78	0.363	0.07	.935

Discussion

This is the first study that seeks to examine the relationships between the performance values obtained in different jump tests and the top score recorded in a BMX race according to rider level. The results of this study reveal the existence of an indirect relationship between the time taken to complete the circuit and the jump height reached in the SJ (r: −.801; p: .017), the CMJ (r: −.798; p: .018) and the DJ (r: −.782; p: .022), which suggests that developing different power contents in specific training of concentric capacity (SJ), explosive elasticity (CMJ) and explosive elastic reflex (DJ) may bear a direct relationship with race times. These results tally with those reported by Bertucci et al. (2007), who found a statistically significant relationship between the height reached in these jumps (SJ and CMJ) and the amount of time needed to complete different parts of the circuit. This all suggests that jump tests could be a predictive tool of performance in BMX in certain distances and circuits with similar characteristics to the one used in this study.

On the other hand, no statistically significant relationships were found between EI, FI and the best score on the circuit, a result which could be attributed to several reasons. First, it is possible that the stretch-shortening cycle (SSC) which occurs during a BMX race is of a lesser magnitude and takes place much more slowly than in other types of situations, like in plyometric training. This would generate a lower level of force during the concentric phase of motion, since a direct relationship has been found between a lower duration of the isometric stabilisation phase (transition between the eccentric and concentric phase) and stronger impulsion during the concentric phase (Wilson et al., 1991). On the other hand, the joint positions adopted during the different specific technical patterns made throughout the test (pedalling, jumping and pumping), the scant variability in the working angles (between 0% and 5%) and the major role played by the arms in reducing the vertical impulsion generated could lead to a lower involvement of the elastic structures during the tests (Cowell et al., 2012; Doré et al., 2006). Furthermore, the performance obtained in the first few metres of the race seemed to condition the end result enormously (Cowell et al., 2012; Rylands & Roberts, 2014).

Based on the data obtained in this study, we suggest the use of tests in BMX that allow information to be obtained about the rider's FI, since the use of relative values ignores important factors like the absolute force produced. These factors are fundamental in the first few metres of the race, when the riders have to overcome inertia and achieve the maximum acceleration possible. Theodorou et al. (2013) reported a significant correlation between the absolute values obtained in 30-second vertical jump tests and the anaerobic power developed in the Wingate pedalling test.

Several limitations of this study should be borne in mind, the first being the sample size analysed. Although the sample in this study was small, the high proficiency of the EG riders, along with the need for the RG to match the rest of the sample analysed, contributed to a smaller sample size. On the other hand, no partial times were taken for each part of the circuit, which could have improved the sensitivity of the variables chosen. Furthermore, different types of circuits should be studied in order to detect the force profiles for each of them, and future studies which analyse larger samples of riders on a greater number of circuits are therefore needed.

Conclusions

The results of this study suggest that there is a direct relationship between the best score obtained in BMX and jumping capacity in the SJ, CMJ and DJ tests. The absolute values in jump height for the SJ, CMJ and DJ were higher in the EG. No significant differences were found for the EI and FI variables, despite the fact that the absolute values of the EG were higher than those of the RG.

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Swimming Performance After an Eccentric Post-Activation Training Protocol

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Abstract

Applying maximum conditioning exercises temporarily improves muscle contractility thanks to post-activation performance enhancement (PAPE). However, it is now known whether the system can improve its adaptability to the procedure through a training based on the conditioning exercises themselves. This study set out to test a PAPE protocol in 14 swimmers before and after a training period. Initially, the subjects' strength in both the lower and upper extremities was tested. Subsequently, the effects of two types of warm-ups were tested in a 50-metre swimming test, one a standard warm-up and the other one a PAPE which included maximum repetitions executed on eccentric training machines. A 6-week training protocol was then applied (2 days/week), in which maximum repetitions were executed on eccentric training machines, and the effects were once again studied both on the strength tests and after both warm-ups. The performance improved at 15 metres after the PAPE compared to the standard situation, but not in the subsequent metre marks. After the 6 weeks, increases in strength in the lower extremities (14.46%) and upper extremities (12.4%) were recorded. Following the application of the PAPE warm-up, the starting speed increased and swimming time and speed improved at 25, 40 and 50 metres, which suggests that the subjects were capable of attaining a better balance between fatigue and potentiation.

Keywords: speed swimming, warm-up, power, dryland training, strength

Introduction

Any increase in speed, or actions taken in a swimming test, require a proportional increase in the strength and muscle power applied in the water or at the starting block, as well as an increase in the capacity and efficiency of the energy-production systems to maintain those requirements (Voronstov et al., 2011). The muscles work and make joint movements through contractions, which are characterised by producing strength and certain changes in length in discreet time intervals (Nasirzade et al., 2014). This suggests the existence of a logical relationships between strength skills and swimmers' performance.

In high-level competition, the difference between winning and losing a race is often determined by a fraction of a percentage difference in performance. For decades, coaches and scientists have tried to prepare athletes to perform at their maximum skill level during competition. One aspect of this preparation includes the warm-up and all the activities done in the 5-15 minutes prior to a race, since they can have a crucial effect on performance. Specifically, making brief muscle contractions at almost maximum intensity has been identified as the forerunner of an improved effect on muscle contractile capacity in terms of both strength and speed (Gilbert & Less, 2005; Seitz et al., 2016). This effect has been termed post-activation performance enhancement (PAPE) (Cuenca-Fernández et al., 2017).

One possible mechanism behind PAPE may be the positive effect of increasing muscle temperature, together with an increase in the volume of intracellular fluid in the connection and adhesion of the crossbridges which make muscle contraction possible (Blazevich & Babault, 2019). On the other hand, the effect of PAPE may also be due to the increase in neuron activation which has been detected along the backbone after any kind of intense muscle contractions (Chiu et al., 2004). Finally, the effect of PAPE may also be due to the phosphorylation of the myosin light chain (Baudry & Dechatau, 2007a; Grange et al., 1998). After a maximum muscle contraction, there is an increase in the calcium ions released in the sarcoplasmic reticulum, which are in charge of adhering to the tropomyosin and rotating the fine filament in which the actin is covered. Through this rotation, actin and myosin come into direct contact, making the crossbridges between these two molecules and consequently muscle contraction possible, thanks to the push movement that myosin produces by its very nature. Once this push has occurred, the myosin needs to separate from the actin and once again pivot its head to a distal position, where it will adhere to a new actin molecule. However, to achieve this effect, this protein needs to be phosphorylated, that is, recharged or energetically impelled for this distal rotation movement to happen inside the muscle fibre as the result of a chemical-physiological action. However, this phosphorylation effect only occurs when the stimulus which caused the previous muscle contraction is intense enough, since the organism interprets it as a response mechanism to the signs of fatigue caused (Baudry & Duchateau, 2007b; Grange et al., 1998).

The benefits of PAPE are more effective when a rest period is provided between the conditioning exercise and the competitive activity (Seitz et al., 2015). This reasoning makes sense bearing in mind the model proposed by Sale (2004), since fatigue and potentiation are two inherent responses to contractile activity, and the predominance of one over the other may have a crucial influence on performance. In trained athletes, this state of fatigue may dissipate relatively quickly, while the phosphorylation state can remain active for up to 5-8 minutes until the organism requires the same maximum muscle contraction again. Therefore, finding the window of opportunity in which to do the competitive activity with the absence of fatigue while the neuromuscular system remains in a potentiated state is essential to obtaining the athlete's maximum performance (Tillin & Bishop, 2009). This makes PAPE a method with a highly individualised application and response methods conditioned by the physical condition of the athletes to whom it is applied.

One of the principles of PAPE is providing a conditioning exercise that is as similar as possible to the real action (Seitz et al., 2016; Tillin & Bishop, 2009). Therefore, if the body movement is the outcome of a clearly defined, particular sequence of activation of certain motor units to produce the strength and movements required to make a given movement, then identifying the most biomechanically optimal exercise to stimulate the motor units needed for a specific task, in this case swimming, is extremely important. One study (Naczk et al., 2016) which analysed the relationships between specific strength training using an inertia training

machine and swimming performance found significant improvements at the 50- and 100-metre marks, which were associated with the gains in strength and power caused by the training. Therefore, it was used as inspiration when applying the protocols presented below.

This study experimented with the effects of a standard warm-up on performance in a speed swimming test compared to a PAPE warm-up which included specific maximum strength exercises executed on an eccentric training machine. In the second phase, the subjects underwent a 6-week training which included the same exercises as in the first phase, and the effects after a standard warm-up and the PAPE warm-up were studied once again. The strength values of the subjects' upper and lower extremities were studied both at the beginning of the experiment and after the 6-week training period.

Methodology

Sample

Fourteen trained swimmers (7 males and 7 females) participated in the study. They provided their informed consent, and the swimmers under the age of 18 also provided parental permission. Their physical characteristics were: age 18.37 ± 1.41; weight 72.46 ± 8.97 kg; and height 1.78 ± 0.11 m. All the swimmers were recruited only if they had been participating in federated competitions for at least five years. They usually did a polarised training regimen, which enabled power and speed to be developed while lowering the volume of aerobic training (Hydren & Cohen, 2015).

None of the swimmers took narcotics or performance-enhancing substances. The tests were planned to be carried out just before their daily training time, and the subjects were asked to avoid any physical activity several hours before. All the procedures were carried out in accordance with the Helsinki Declaration on research with human subjects, and the study was approved by the university's Ethics Committee with number 852.

Experimental approach

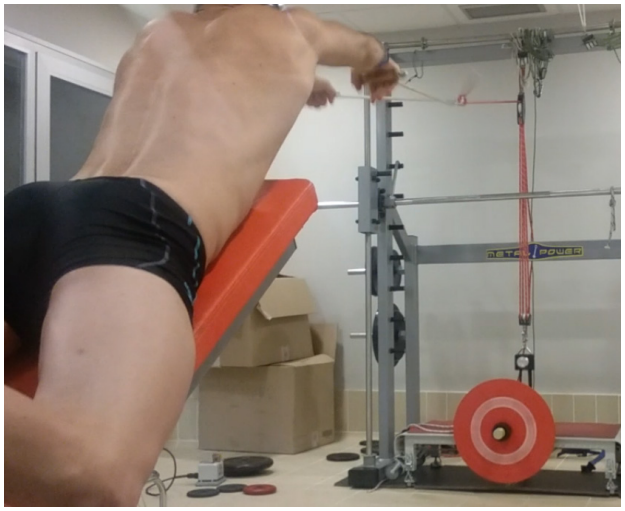
A repeated measures design was used to compare four different situations. First, the physical state of the subjects was evaluated, and then the effects on their performance in a 50-metre test were studied after a standard warm-up and after the PAPE warm-up. Secondly, a 6-week training was applied, and the effects after a standard and PAPE warm-up were studied again.

The physical condition of the subjects was evaluated by a maximum repetitions test performed on both the lower and upper extremities. Both tests found the maximum load that the subjects could move, and the power and speed curves expressed at 25, 50, 75 and 100% of the subjects' maximum resistance (MR) were obtained (González-Badillo & Sánchez-Medina, 2010).

The PAPE warm-up was conducted via a protocol entailing four repetitions of exercises of the upper and lower extremities on an adapted eccentric training machine (YoYo™ Technology AB, Stockholm, Sweden). The exercises for the lower extremities consisted of making the flexion-extension movement that is made when starting a swim race in the same position and placement of the legs (asymmetrically) that swimmers use on the starting block (Figure 1). The conditioning exercise for the upper extremities consisted of making arm pulling movements similar to the arm movements in swimming while reclining

Figure 1
PAPE induction for the lower extremities on an nHANCE™ Squat Ultimate eccentric training machine (YoYo™ Technology AB, Stockholm, Sweden)

Figure 2
PAPE induction for the upper extremities on an nHANCE™ Squat Ultimate adapted eccentric training machine (YoYo™ Technology AB, Stockholm, Sweden)



on a training bench from which they pulled grips connected to the eccentric training machine by ropes (Figure 2).

Procedure

The experimental setting was an indoor 25-metre pool (with water and air temperatures of 28.1ºC and 29.0ºC, respectively). Each swimmer individually did 3 protocols on 3 separate days (one protocol per day). In the first session, strength was analysed by a MR test on a training machine in accordance with the guidelines proposed by the American College of Sports Medicine (Ferguson, 2014). The machine was connected to a T-Strength iso-inertial dynamometer (Ergotech, Murcia, Spain), which transmitted all the values recorded during the strength test directly to a computer. The exercises done in the strength test were based on the study by Cuenca-Fernández et al. (2018), which included: 1) strides on a training machine with the same position and asymmetrical leg placement that swimmers use on the starting block, and 2) exercises done on an adapted training machine with pulleys that allowed arm pulling movements similar to swimming strokes to be made.

In a second session, reference points on the swimmers' hips, knees, ankles, hands and elbows were marked (using a black marker). After that, the swimmers were informed about the test protocol, which included a warm-up, a rest period, and finally a 50-metre test at maximum intensity. Each test was done only once to simulate competition "one attempt" conditions (FINA regulations). Throughout the session, a researcher monitored each subject's rest time. A sound stimulus similar to what is used in competition was used as the starting signal. In each test, the subjects were asked to climb onto the starting block. Once in position, they were given the "take your marks" signal and then the starting signal was given.

First, all the swimmers did the standard warm-up (SWU) protocol, which consisted of 400 metres of varied strokes and two starts from the block. After swimming, the participants began a dynamic stretching protocol which consisted of exercises of the muscles most closely associated with dives and arm pulls. Each exercise was done 10 times, and the whole set was repeated twice. At all times, the dynamic stretching protocol was conducted under the supervision of a researcher, who made sure that it did not last more than 4 minutes and that they were allowed at least 6 minutes of rest before doing the 50-metre test at maximum intensity. All the tests were recorded with several cameras placed along the length of the pool with the goal of getting kinematic variables related to swimming.

Two hours later, the swimmers did the SWU followed by the PAPE induction by means of a protocol proposed by Cuenca-Fernández et al. (2018), which consisted of doing four repetitions of exercises of the lower and upper extremities on an adapted eccentric training machine (YoYo™ Technology AB, Stockholm, Sweden) at maximum intensity. This warm-up was called EWU.

In the course of the following 6 weeks, the swimmers performed a training protocol 2 days a week in which they carried out exactly the same exercises as they had done during the PAPE warm-ups. On arrival, the swimmers did the warm-up of 400 metres of varied strokes, followed by the dynamic stretching protocol and then the exercises on the eccentric training machines. At the end of the 6 weeks, they did the strength tests once again, as well as the swimming tests after a standard warm-up and the PAPE warm-up, following the same protocols and methodologies mentioned above.

Results

Descriptive statistics were obtained, and all the data were expressed as the Mean ± SD with a 95% confidence interval (SPSS Version 21.0, IBM, Chicago, IL, USA). After the Saphiro-Wilk normality test, a one-way repeated measures ANOVA was applied to the four protocols to determine inter- and intra-subject differences in the kinetic and kinematic variables. To detect differences, the alpha level was set at $<.05$. The comparisons by pairs were performed using the Bonferroni method to control type-1 errors.

An improvement was found in the strength test after the 6 weeks of training, which was particularly significant for the lower extremities ($p<.01$), where the subjects' MR values improved from 76.53 ± 21.97 kg to 89.46 ± 24.78 kg after the 6 weeks of training. For the upper extremities, the values also improved ($p<.05$), from 34.34 ± 7.01 kg to 39.20 ± 7.86 kg (Figure 3).

The power-speed curves obtained in the strength tests showed an improvement in the execution of both power and speed exercises, which was particularly significant in the power values of the lower extremities (Figure 4, above), executed at 25 ($p<.05$), 50 ($p<.01$), 75 ($p<.05$) and 100% of MR ($p<.05$). However, the values found in the upper extremities remained the same after the 6 weeks of training in the executions at 25, 50 and 75% of the MR, and these values were even lower at 100% of MR (Figure 4, below).

The analysis revealed differences in swimming times and speeds at 15 metres after the PAPE warm-up compared to the standard warm-up (T15: $F_{3.48}=5.073$; $p=.028$; S15: $F_{3.48}=5.082$; $p=.031$), but there were no differences in the other tests even after the 6 weeks of training either after the standard warm-up or after the PAPE warm-up (Table 1). Differences were found in swimming time and speeds following the PAPE after the 6 weeks of training compared to the standard warm-up after the 6 weeks of training at the 40-and 50-metre marks (T40_PAPE: $F_{3.48}=4.625$; $p=.045$; S40_PAPE: $F_{3.48}=4.028$; $p=.039$; T50_PAPE: $F_{3.48}=5.795$; $p=.024$; S50_PAPE: $F_{3.48}=4.982$; $p=.033$). However, no statistically significant differences were found at 25 metres, even though the values were better after the PAPE warm-up (Table 1).

The starting speed values recorded at the hip while in flight were different after the 6 weeks of training applying the PAPE protocol compared to the values

Figure 3
Maximum strength values recorded in the maximum repetitions (MR) test for the lower and upper extremities at the beginning of the experiment (PRE) and after the 6 weeks of eccentric training (POST)

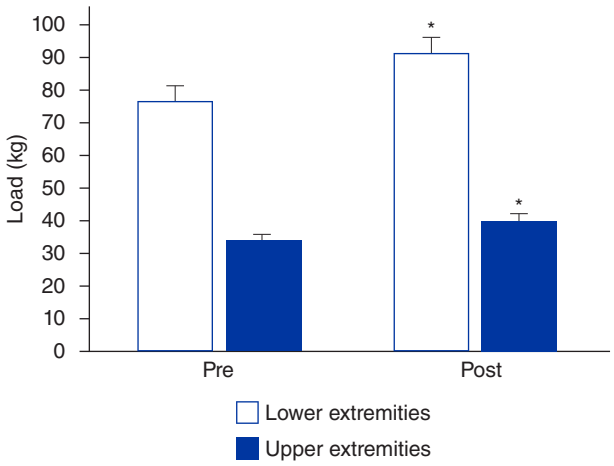


Figure 4
Power-speed curves obtained in the strength tests performed on the lower extremities (above) and upper extremities (below) at the beginning of the experiment and after the 6 weeks of training. Values expressed at 25, 50, 75 and 100% of the subjects' MR

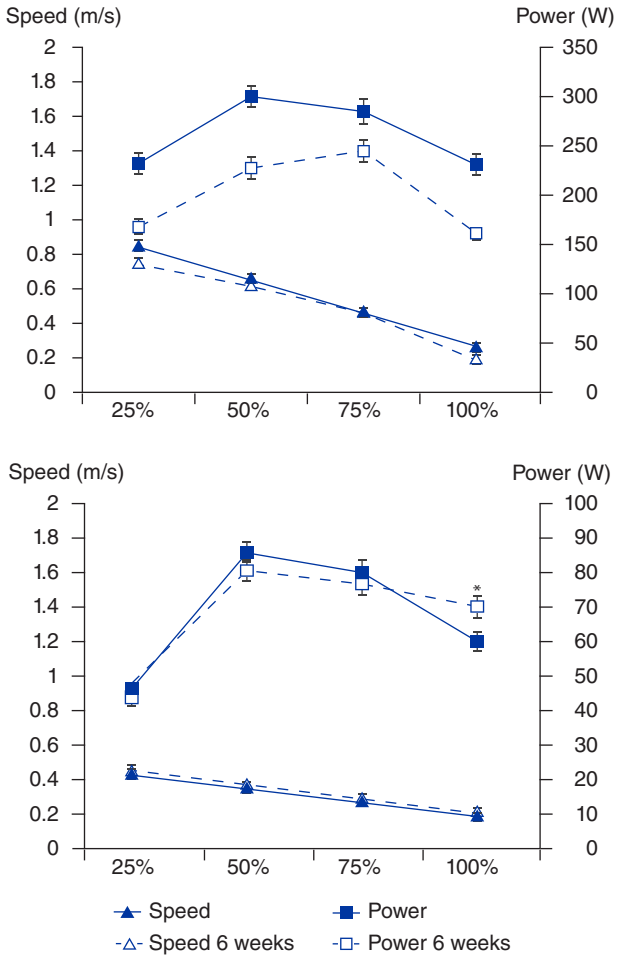


Table 1
Mean and standard deviation of the swimming times and speeds (15, 25, 40 and 50 m) and the start of swimming (from the starting signal to the hands' first contact with the water)

	Pre-test				Pre-test + PAPE				Post-test (6 weeks)				Post-test (6 weeks) + PAPE			
	T	SD	Speed	SD	T	SD	Speed	SD	T	SD	Speed	SD	T	SD	Speed	SD
15 m	7.30	± 0.50	1.71	± 0.13	7.12*	± 0.90	2.17*	± 1.62	7.37	± 0.55	1.70	± 0.13	7.34	± 0.57	1.70	± 0.12
25 m	13.51	± 0.85	1.53	± 0.10	13.57	± 1.03	1.50	± 0.13	13.74	± 0.96	1.52	± 0.10	13.68	± 1.00	1.53	± 0.13
40 m	21.76	± 1.38	1.64	± 0.10	21.95	± 1.64	1.61	± 0.12	22.14	± 1.53	1.61	± 0.13	21.97#	± 1.62	1.65#	± 0.13
50 m	27.73	± 1.72	1.59	± 0.09	28.08	± 2.18	1.58	± 0.17	28.31	± 2.03	1.54	± 0.14	27.98#	± 2.10	1.59#	± 0.13
Start	0.90	± 0.09	3.28	± 0.39	0.91	± 0.10	3.27	± 0.36	0.91	± 0.08	3.29	± 0.39	0.92	± 0.11	3.31†	± 0.33

* Differences compared to the standard warm-up; # Differences compared to the standard warm-up after the 6 weeks of training; † Differences compared to the PAPE warm-up after the 6 weeks of training.

obtained after the PAPE warm-up at the beginning of the test ($F_{3.36} = 7.042$, $p = .045$). There were no significant differences in the flight time recorded during the start in any of the 4 protocols (Table 1).

Discussion

The first objective of this study was to evaluate whether muscle performance may be higher after maximum intensity conditioning exercises. The results showed that performance can be improved at the 15-metre mark after a warm-up based on PAPE. The second objective of the study was to evaluate the effects of that same kind of warm-up after a 6-week training using the same protocols, and the results showed that the subjects attained a better balance between fatigue and potentiation. Furthermore, this study also demonstrated that the subjects were capable of improving their absolute and relative strength after the 6-week training of the warm-up protocol.

The study by Kilduff et al. (2011) was the first case in which PAPE protocols were applied to swimming starts from the swim deck. Significant improvements were found on the peak strength generated at the starting block; however, no difference was found at the 15-metre mark. The swimmers in this study did not experience any significant change in the variables collected at the starting block, even though they were able to reach the 15-metre mark in less time (Table 1). According to some authors, it is important to consider the influence of the starting block phase on the performance obtained in the components after the start, and therefore it is important for swimmers to optimise this phase (Mason et al., 2007). Some studies have demonstrated the relationship between strong lower extremities and good start performance; the results suggest that the subjects who tended to have higher speeds at the starts also had higher absolute and/or relative strength values on the lower extremities (Béretic et al., 2013). After the 6 weeks of training, the subjects showed an improvement in the strength tests, which was especially significant for the lower extremities (Figure 3). This did not lead to a major improvement in starting speed after the standard warm-up, but it did after the PAPE warm-up had been applied (Table 1). These results were in accordance with the study by Cuenca-Fernández et al. (2015), which demonstrated that swimmers with higher relative strength values in their lower extremities were not only capable of executing a better start but were also capable of reacting to the PAPE protocols better. If the swimmers in this study were capable of increasing their absolute strength values after 6 weeks of training, then they also improved their relative strength and thus their capacity to react better to the PAPE protocols.

In the swimming phase, a lower time at the 15-metre mark was only obtained after PAPE: however, the lower time at 50 metres was obtained after the standard warm-up, which suggests that there is a deterioration in swim speed after PAPE (Table 1). Fatigue and potentiation coexist as responses to PAPE, which means that the responses are highly individualised according to the athlete's level or physical condition, and that a more appropriate intensity or rest period must be found for the conditioning activities applied to the upper extremities. The study by Naczk et al. (2016) applied a specific training of the muscles related to the pulling phase in the front crawl for 4 weeks using an inertial training machine. This resulted in improvements in swimming performance at both 50 metres

(–0.76%) and 100 metres (–1.83%), and these improvements were associated with swift gains in strength (12.8%) and muscle power (14.2%), perhaps caused by the major stimulation generated by the eccentric overload. The gains in absolute strength in the upper extremities obtained in this study were 12.4%. However, bearing in mind the values found in the power-speed tests, the exercise chosen for the upper extremities may have not provided enough training stimulus. The values found in the speed of execution worsened, constituting a deterioration with a variability of ~ –11.59%, while the improvements in power had a variability of ~ 5.88% at 25, 50 and 75% of MR, but a worsening of –14.55% when mobilising 100% of the MR (Figures 3 and 4).

In any case, it should be noted that even if the PAPE protocol is applied and a comparison is made with the standard situation, the results compared to the start of the 6 weeks of training worsened (Table 1), the same tendency was not found after the 6 weeks of training, although there were improvements in the final test marks (25, 40 and 50 metres). This result suggests that the subjects were capable of achieving a better balance between fatigue and potentiation, perhaps because they increased their MR value in the upper extremities (Figure 3). Furthermore, according to Morouço et al. (2011), performance in a 50-metre race is more closely related to absolute strength values than to body weight values.

In conclusion, a warm-up based on PAPE protocols may influence performance in the first few metres of a 50-metre race. However, other factors, such as fatigue, may change swimming patterns and yield contradictory, instead of the desired, results. Evaluating and monitoring swimmers' strength via specific strength tests like the ones conducted in this study is a useful, necessary tool which coaches should use more often to self-assess the training procedures they undertake with athletes. One of the main results found in this study, thanks to the strength tests, indicated that the overload offered by the eccentric training machines seems to show more benefits in the training and stimulation of the lower extremities than of the upper extremities, possibly because of the subject's position when doing the exercise and the action of gravity. Future studies should use the same protocol with the application of individual loads as the training method, especially to apply greater intensity to the upper extremities.

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Observational Analysis of the Execution of the "Control" Core Technical/Tactical Concept by Sergio Busquets

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Abstract

This paper is based on match analysis using observational methodology. Its object of study is the execution of the control core technical/tactical concept by Sergio Busquets, the FC Barcelona international midfielder. The observation instrument was developed ad hoc and was a combination of field format and category systems. The recording and coding process was carried out using the Lince software, version 1.2.1. The reliability of the observation instrument designed ad hoc was guaranteed through inter-observer matching calculated using Cohen's kappa coefficient. Within the theoretical framework of Generalisability Theory, the observational instrument was validated and the generalisability of the results derived from the number of sequences analysed was guaranteed. Two complementary diachronic analyses were performed: adjusted residuals analysis with the GSEQ5 program and T-pattern analysis with the Theme program, version 6. The results show regular behaviour patterns in which Sergio Busquets controls the ball with his instep, positioned at the back line of his team with the forward line of the opposing team in front of him. His control also has a tactical intention, namely to switch play towards the opposite side from which the ball enters. The conclusions of this paper are a highly significant starting point for designing tasks whose purpose is to develop the "control" core technical concept on the basis of the analysis of a leading player.

Keywords: football, ball control, Sergio Busquets, observational methodology, generalisability, T-patterns

Introduction

Football analysis is evolving rapidly due to the development of automatic procedures for recording the positioning and movement of players and the ball on the pitch (Rein & Memmert, 2016). However, in spite of fledgling efforts to capture technical/tactical performance automatically (Stein et al., 2017), this type of behaviour is mostly recorded semi-automatically by means of display, recording and coding software (Gabin et al., 2012). Against this background, observational methodology is becoming increasingly germane internationally due to the methodological robustness of the match analyses carried out (Preciado et al., 2019).

Although there are numerous papers in football which use observational methodology and include the analysis of its core technical concepts, none of them concerns the object of study of this paper: "control". Based on the common traits in the specialist literature, control can be defined as the technical action by which the player takes possession of the ball, placing them in an ideal situation to perform a new technical action immediately afterwards and continue the game.

Therefore, this core technical concept is probably one of the best examples of how technique and tactics are inseparable and of how technique underpins the players' tactical decision-making ability. The core technical concept is the means, the functional adaptation of performance to the task, while the tactical intent is the end (Guilherme et al., 2015), and a means cannot be envisaged independently of the end for which it is used (Castelo, 1999).

In football, an isolated movement only takes on its true meaning within the context of the game (Guilherme et al., 2015). Without adequate control, the player's technical/tactical behaviour cannot be harnessed to address changing game situations. Hence it is pertinent to stress the influence that control actions have depending on the player's role and the zone of the field where they are performed (Sarmento, Marcelino et al., 2014).

This paper concerns the observational analysis of the sequences included in the control core technical/tactical concept performed by FC Barcelona 1st Division international midfielder Sergio Busquets. This choice is warranted because a midfielder is a player whose role calls for great variety and quality in the performance of control actions (Maneiro & Amatria, 2018). Furthermore, Busquets trained in youth football at FC Barcelona, a club which is a global leader in combination play (Sarmento, Anguera et al., 2014) and which has a youth academy internationally recognised for its work in technical/tactical training in link-up play (Lapresa et al., 2018).

First of all, the aim was to design an observation system which allows observation, analysis and intervention on the "control" core technical/tactical concept. Subsequently, the paper examines the control actions executed by a leading player: the FC Barcelona international midfielder Sergio Busquets. Fulfilling this second objective will make it possible to produce a technical/tactical model (Maneiro & Amatria, 2018) to be used to guide football player training by means of appropriate task design (Stratton et al., 2004).

Methodology

This paper uses observational methodology (Anguera, 1979). As defined by Anguera et al. (2011), observational design is I/S/M: idiographic (the behaviour of a given player is observed); inter- (a number of observation sessions) and intra- (the behaviour is recorded continuously frame by frame) session monitoring which allows subsequent diachronic analysis; and multidimensional (with different levels of response reflected in the different criteria of the observation instrument). Observation is active, respecting the principle of scientificity, and is live, based on the recordings of the matches broadcast free-to-air.

Participants

In this paper, Sergio Busquets, a leading international midfielder, was specifically selected to provide a benchmark to guide task design in relation to the control core technical concept. This player is in the FC Barcelona first team and plays in the position of defensive midfielder. The sequences making up the observational sampling were extracted from the King's Cup Semi-final (Valencia CF vs. FC Barcelona) played on 6 February 2018 at the Mestalla Stadium, and from the King's Cup Final (FC Barcelona vs. Sevilla FC) played on 21 April 2018 at the Wanda Metropolitano Stadium in Madrid.

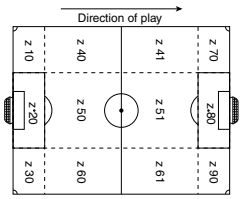
This paper has been approved by the Research Ethics Committee at the University of La Rioja (file no. 17250).

Observation instrument

The observation tool was developed ad hoc and was a combination of field format and category systems. The general approach of the criteria was a field format, although each one was developed in a category system that meets the requirements of completeness and mutual exclusivity. Table 1 sets out the criteria and categories making up the observation instrument (Castellano et al., 2013; Castellano et al., 2007).

Table 1
Overview of the observation instrument

Criterion or dimension	Codes and categories
Reason for beginning the sequence	IMP: retaining possession; IR: recovering the ball; IFTD: direct free kick for the observed team; IFTI: indirect free kick for the observed team; IFJ: offside free kick for the observed team; ISC: kick-off for the observed team; ISB: throw-in for the observed team; ISE: corner kick for the observed team; ISP: goal kick for the observed team.
Consequence of the sequence	CSP: Retaining possession. CIR: Interception by rival – loss of possession. Interruption for the observed team: For/Inside, CAFD; For/Outside, CAFF. Interruption against the observed team: Against/Inside, CCD; Against/Outside, CCF. CGF: Scores goal.
Scoreboard	EM: drawing; W: winning; L: losing.
Zone of the pitch where the action is performed	Own half: safety sector (Z10, Z20, Z30); own half creation sector (Z40, Z50, Z60). Opponents' half: opponents' half creation sector (Z41, Z51, Z61); definition sector (Z70, Z80, Z90).
Context of interaction	Ball in the possession of the observed team: RMO: the back line has the ball in front of the middle line of the opposing team. RAO: the back line has the ball in front of the forward line of the opposing team. MRO: the middle line has the ball in front of the back line of the opposing team. MMO: the middle line has the ball in front of the middle line of the opposing team. MAO: the middle line has the ball in front of the forward line of the opposing team. ARO: the forward line has the ball in front of the back line of the opposing team. AMO: the forward line has the ball in front of the middle line of the opposing team. GO: the goalkeeper of the observed team has the ball. Ball in the possession of the opposing team: RMR: the back line has the ball in front of the middle line of the observed team. RAR: the back line has the ball in front of the forward line of the observed team. MRR: the middle line has the ball in front of the back line of the observed team. MMR: the middle line has the ball in front of the middle line of the observed team. MAR: the middle line has the ball in front of the forward line of the observed team. ARR: the forward line has the ball in front of the back line of the observed team. AMR: the forward line has the ball in front of the middle line of the observed team. GR: the goalkeeper of the opposing team has the ball.
Phase	IAP: start prior technical/tactical action; FAP: end prior technical/tactical action; ICJ: start control; FCJ: end control; IAVJ: start technical/tactical action linked to the control by the observed player; FAVJ: end technical/tactical action linked to the control by the observed player; IAJT: start technical/tactical action by the player who intervenes after the observed player; FAJT: end technical/tactical action by the player who intervenes after the observed player.
Technical/tactical action	C: control of the ball; T: shot; CP: control plus pass; CM: control plus running with the ball and/or dribbling; CMP: control, running with the ball and/or dribbling plus pass; CB: header; IOC: occasional interruption with continuity.
Control contact surface	PL: sole of the foot; IN: inside of the foot; EX: outside of the foot; TA: heel of the foot; EMP: instep of the foot; OT: parts of the body other than the foot: chest, thigh, etc.
Incoming ball positioning in the control	BEAD: front-right quadrant; BEAI: front-left quadrant; BETD: rear-right quadrant; BETI: rear-left quadrant.
Outgoing ball positioning in the control	BSAD: front-right quadrant; BSAI: front-left quadrant; BSTD: rear-right quadrant; BSTI: rear-left quadrant.
Player positioning when controlling incoming ball	JEAD: front-right quadrant; JEAI: front-left quadrant; JETD: rear-right quadrant; JETI: rear-left quadrant.
Player positioning after controlling and playing the ball	JEAD: front-right quadrant; JEAI: front-left quadrant; JETD: rear-right quadrant; JETI: rear-left quadrant.
Opponents in the centre of play	S: centre of play unoccupied; C: centre of play congested; SO1: sector occupied 1; SO2: sector occupied 2; SO3: sector occupied 3; SO4: sector occupied 4; SO12: sectors occupied 1 and 2; SO13: sectors occupied 1 and 3; SO14: sectors occupied 1 and 4; SO23: sectors occupied 2 and 3; SO24: sectors occupied 2 and 4; SO34. sectors occupied 3 and 4; SL1: sector unoccupied 1; SL2: sector unoccupied 2; SL3: sector unoccupied 3; SL4: sector unoccupied 4.



Recording and coding

The observational sample gathered amounted to 105 sequences which include the control core technical concept performed by Sergio Busquets. Each sequence consists of a maximum of eight rows of the record: start and end of the technical/tactical action by the player who intervenes before the observed player (dimensions recorded: reason for beginning the sequence, zone, context of interaction, technical action); start and end of the control action performed by Sergio Busquets (recorded dimensions: zone, context of interaction, technical action, control surface, incoming ball positioning, incoming player positioning, opponents in the centre of play); start and end of the technical/tactical element after the control performed by Sergio Busquets (dimensions recorded: zone, context of interaction, technical action); start and end of the technical/tactical action of the player intervening on the ball after the player observed (dimensions recorded: zone, context of interaction, technical action, consequence of the sequence).

Following Bakeman (1978), type IV, time-based and concurrent data were used; i.e. the data include the time parameter and they concur. The use of this type of data is consistent since it is an intra-session and multidimensional monitoring design. It should be added that in the GSEQ analysis software environment the data are multievent (Bakeman & Quera, 1995).

The recording and coding of the matches played (Figure 1) was carried out using the LINCE software, version 1.2.1 (Gabin et al., 2012). Subsequently, the data obtained were exported and recoded for further analysis in the GSEQ and THEME programs. In both cases, the specific coding syntax of both software programs was used to determine, according to the internal logic of the game, that the adjusted residuals analysis in the lags considered and the detection of T-patterns would be carried out intra-sequence.

Data quality control

In this research, and after a training process following Anguera (2003), two observers recorded the corresponding data packages. The first observer recorded the entire observational sampling while the second observer recorded 10% of the total time.

In this research, the reliability of the observation instrument was guaranteed in the form of concordance using Cohen's kappa coefficient. The "phase", "control contact surface", and "scoreboard" criteria achieved complete concordance. The other criteria earned a rating of almost perfect agreement based on Landis and Koch (1977), with Cohen's kappa values higher than 0.80.

In order to complete the quality of the data in this research, the Generalisability Theory (GT) – Cronbach et al. (1972) – was used, applied in the SAGT software, version 1.0 (Hernández-Mendo et al., 2016). The generalisability design was developed in concordance with the phases expounded by Blanco-Villaseñor (1993):

Figure 1
Capture of a moment of the recording with the observation instrument in LINCE software, version 1.2.1

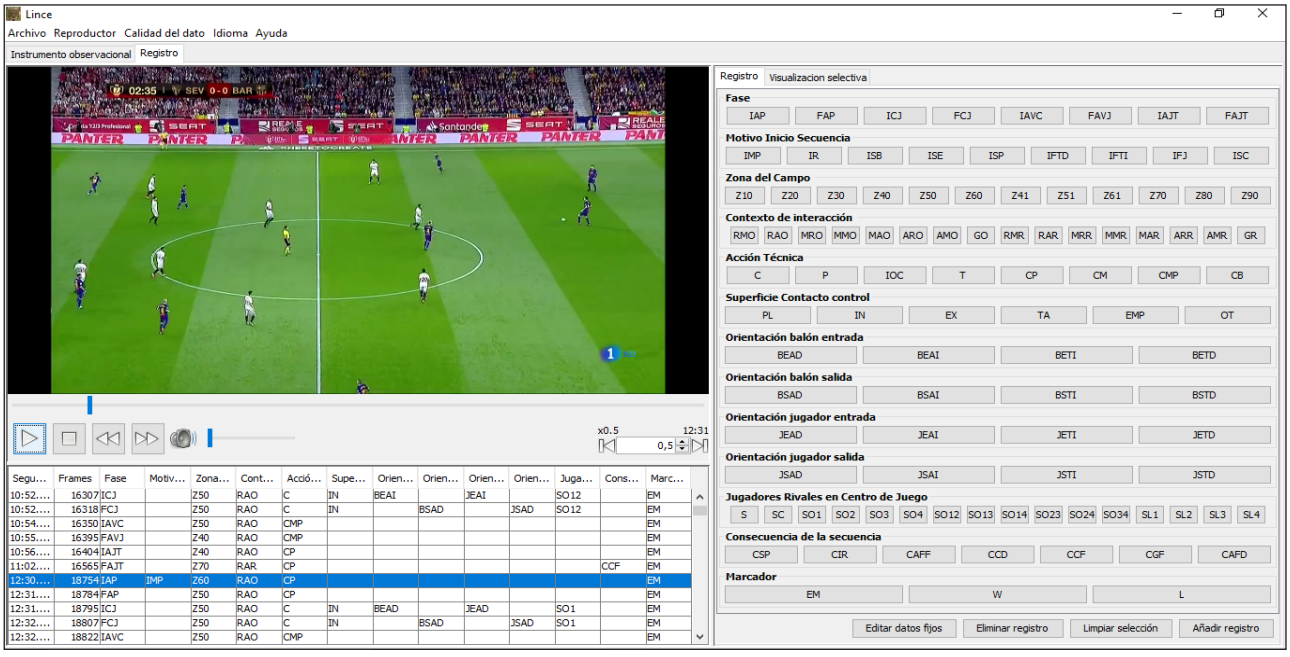


Table 2
Measurement plan results [Categories] / [Sequences]

Variation sources	Sum of squares	Gl	Mean square	Random	Mixed	Corrected	%	Standard error
[Sequences]	6.871	104	0.066	-0.005	-0.005	-0.005	0	0
[Categories]	5571.829	97	57.442	0.542	0.542	0.542	50.101	0.078
[Sequences][Categories]	5444.824	10088	0.54	0.54	0.54	0.54	49.899	0.008

1st phase. Two-faceted observation plan arranged in a "crossed" manner: Sequences (S), with 105 levels; Categories (C), with 98 levels, the 98 categories corresponding to the variable criteria of the observation instrument; 2nd phase. Estimation plan, the universe to which the data were generalised is estimated for an infinite population; 3rd phase. Measurement plan, where two measurement plans were made: [Categories] / [Sequences], to evaluate the generalisability of the results based on the number of sequences observed; [Sequences/Categories], to evaluate the validity of the observation instrument within the GT theoretical framework; 4th phase. No optimisation plan was needed.

Table 2 shows the results of the [Categories] / [Sequences] design conducted in the records for Sergio Busquets. The analysis shows that the greatest variability is associated with the [Categories] facet, 50.101%; followed by the interaction between the [Sequences] / [Categories] facets, 49.899%. The results for the Categories / Sequences measurement plan reflect the uniformity of the sequences that make up the observational sampling, since a relative G coefficient (e^2) = .991 is derived. These results confirm that 105 sequences are sufficient to ensure the generalisability of the results derived from the sequences which include the control actions performed by Sergio Busquets. Accordingly, an optimisation plan was not necessary.

Furthermore, the validity of the observation instrument was addressed based on the results of the measurement plan which involves placing the "categories" facet in the instrumentation facet. In this methodological framework, an instrument will be valid when the variability corresponding to the categories facet is very high, which translates into a generalisability coefficient equal to or close to zero. In this case, the relative generalisability coefficient (e^2 = .000) reflects the categories facet's discrimination capacity and makes it possible to guarantee the validity of the observation instrument designed within the theoretical framework of generalisability theory.

Data analysis

From the methodological standpoint, this paper is based on match analysis using observational methodology (Sarmento, Anguera et al., 2014), involving the complementary use of lag-sequential analysis (Bakeman & Quera, 1995) and T-pattern detection (Magnusson, 1996) to accomplish its disciplinary objectives. Lapresa et al. (2013) showed that although certain results obtained with both techniques can be considered convergent, they sometimes reveal two different sides of the reality of the same object of study. Therefore, in this paper an adjusted residuals analysis was conducted with the GSEQ5 program (Bakeman & Quera, 1995) and a T-pattern analysis with the THEME program, version 6 Edu (Magnusson, 1996).

The GSEQ5 software was used to calculate the adjusted residuals between given and target behaviours, where $z_{rc} = x_{rc} - e_{rc} / \sqrt{e_{rc}(1-p_c)(1-p_r)}$: X_{rc} is the frequency of cases in each box of the table; e_{rc} is the frequency of cases expected by chance; P_c is the proportion of cases in each column; and P_r is the proportion of cases in each row. The significant differences between conditional (based on observed frequencies) and unconditional (based on expected frequencies) probabilities at lag 0 or co-occurrence and at lag +1 (behaviours occurring immediately after – one row after the given behaviour was recorded) were interpreted subsequently.

The following search parameters were selected to detect T-patterns: minimum occurrences: equal to or greater than 3; significance level: a significance level of .005 was used; redundancy reduction: if more than 99% of the occurrences of a new detected time pattern start and end at almost the same time as the time patterns already detected, the new time pattern was discarded; fast requirement activated: whereby the lower time limit of the critical interval is set to a value equal to 0 and the components of the critical interval tend to occur in relatively quick succession.

Results

Adjusted residuals analysis

Table 3 presents transitions greater than 1.96 ($p < .05$), which indicate a greater probability of occurrence than expected by chance (activation relationship between given behaviour and target behaviour); and transitions less than or equal to –1.96 ($p < .05$) that show an inhibition relationship between behaviours.

In lag 0, the intention was to find out to what extent there was a statistically significant relationship – either of association or inhibition – in the co-occurrence of behaviours in the dimensions: "incoming ball positioning" and "incoming player positioning"; "outgoing ball positioning" and "opponents in the centre of play"; "outgoing player positioning" and "opponents in the centre of play".

In turn, the sequential analysis of lag 1 was designed to show the statistically significant relationship – either of association or inhibition – between behaviours corresponding to consecutive rows of the record, which made it possible to drill down into the relationship between the behaviours in the dimensions: "incoming ball positioning" and "outgoing ball positioning"; "incoming ball positioning" and "outgoing player positioning"; "incoming player positioning" and "outgoing player positioning".

Table 3
Sequential analysis of lags 0 and +1; given behaviours are reflected in the left column. The target behaviour and the value of the statistically significant adjusted residual are added In the corresponding cells

	Lag 0		Lag 1	
	Activation	Inhibition	Activation	Inhibition
BEAD	JEAD (7.11);	JEAI (-3.41); JETI (-2.85); JETD (-2.26)	BSAI (5.28); JSAI (5.28)	BSAD (-4.52); JSAD (-4.52)
BEAI	JEAI (7.53)	JEAD (-4.48); JETD (-2.6)	BSAD (4.18); JSAD (4.18)	BSAI (-3.98); JSAI (-3.98)
BETI	JETI (7.98)	JEAD (-2.07); JEAI (-2.85)		BSAI (-2.29); JSAI (-2.29)
BETD	JETD (8.48)	JEAI (-2.56)		
BSAD	JSAD (10.25)	JSAI (-6.96); JSTI (-2.37); JSTD (-3.34)		
BSAI	JSAI (10.25)	JSAD (-6.96); JSTI (-2.15); JSTD (-3.02)		
BSTI	JSTI (10.25)	JSAD (-2.37); JSAI (-2.15);		
BSTD	JSTD (10.25); SL3 (2.33)	JSAD (-3.34); JSAI (-2.56)		
JSTD	SL3 (2.33)			
JEAD			JSAI (4.17)	JSAD (-2.83)
JEAI			JSAD (3.19)	JSAI (-3.41)

T-pattern detection

In the recording of the 105 sequences that included the control core technical concept performed by Sergio Busquets, 822 multi-events – recording rows, made up of 476 standard multi-events – were counted, which means a frequency of appearance of each standard multi-event of 1.72. As a result of their information potential, Table 4 shows the T-patterns detected which, fulfilling the search parameters, reflect the start player control (SPC) and end player control (EPC) dimensions.

Table 4
T-patterns detected according to search parameters and criteria, grouped according to the consequence of the sequence. The string format pattern, the sequence number of the record in which each occurrence of the T-pattern takes place and the order number for its identification are shown for each T-pattern

Consequence	Opponents in the centre of play	String format pattern	Occurrences and sequence no.	*n*
Incoming positioning front-right and outgoing positioning front-left	Sector 1 occupied	((fap,z50,rao,cp,em icj,z50,rao,c,in,bead,jead,so1,em) fcj,z50,rao,c,in,bsai,jsai,so1,em)	*n*=3 (7,29,31)	1
	Sectors 1 and 2 occupied	(icj,z51,rao,c,in,bead,jead,so12,em (fcj,z51,rao,c,in,bsai,jsai,so12,em iavc,z51,rao,cp,em))	*n*=3 (5,11,19)	2
		(icj,z50,rao,c,in,bead,jead,so12,em fcj,z50,rao,c,in,bsai,jsai,so12,em)	*n*=3 (4,50,73)	3
Incoming positioning front-left and outgoing positioning front-right	Sectors 1 and 2 occupied	((fap,z50,rao,cp,w icj,z50,rao,c,in,beai,jeai,so12,w) fcj,z50,rao,c,in,bsad,jsad,so12,w)	*n*=3 (66,83,88)	4
		(icj,z50,rao,c,in,beai,jeai,so12,em fcj,z50,rao,c,in,bsad,jsad,so12,em)	*n*=4 (16,18,30,71)	5

Discussion and conclusions

The reliability of the observation instrument designed ad hoc was guaranteed through inter-observer matching calculated using Cohen's kappa coefficient. Within the theoretical framework of the Generalisability Theory (Cronbach et al., 1972), the observational instrument was validated and the generalisability of the results derived from the number of sequences analysed was guaranteed.

To accomplish the research's disciplinary objective, two complementary analysis techniques at the forefront of observational methodology were used: lag-sequential analysis and T-pattern detection. The former enjoys appropriate conceptual and procedural support in the GSEQ software (Bakeman & Quera, 1995) and has been used in football for match analysis (Sarmento, Anguera et al., 2014). As for T-pattern detection (Magnusson, 1996) using the THEME software, it should be noted that its use in football has increased considerably (Camerino et al., 2012) due to the fact that the software has been free for academic use since 2012 (http://www.patternvision.com).

The lag-sequential analysis made it possible to establish the statistically significant association or inhibition relationship between the related variables, whereas the T-patterns detected constitute a tangible example with evident informative potential (Amatria et al., 2017) and make it possible to classify game sequences including the controls performed by Busquets. The intention was to use the results derived in this paper to generate real and efficient benchmarks that are a milestone towards which performance can be directed in terms of the development of the control core technical/tactical concept.

Statistically significant association (shown in Figure 2) or inhibition relationships were established based on the sequential adjusted residuals analysis performed.

a) The incoming ball and player positioning is the same in all four quadrants (front-left; front-right; rear-left; rear-right). The outgoing ball and player positioning after the control action is also the same. Both conclusions concerning the characteristics of a good encounter between the player and the ball are in line with the recommendations made by Castelo (1999) and Hughes (1990).

b) Statistically significant association relationships were detected when the ball enters (incoming ball positioning) via the front quadrants (left-right), and Sergio Busquets plays the ball (outgoing ball positioning) through the opposite front positioning (right-left). This is reinforced by the fact that there are also inhibiting relationships when the ball exits via the same quadrant as the one through which it entered, except in the rear-right quadrant (BETD). These results confirm the need to approach ball control as a core technical/tactical concept and as a link bringing continuity to the player's subsequent actions (Guilherme et al., 2015).

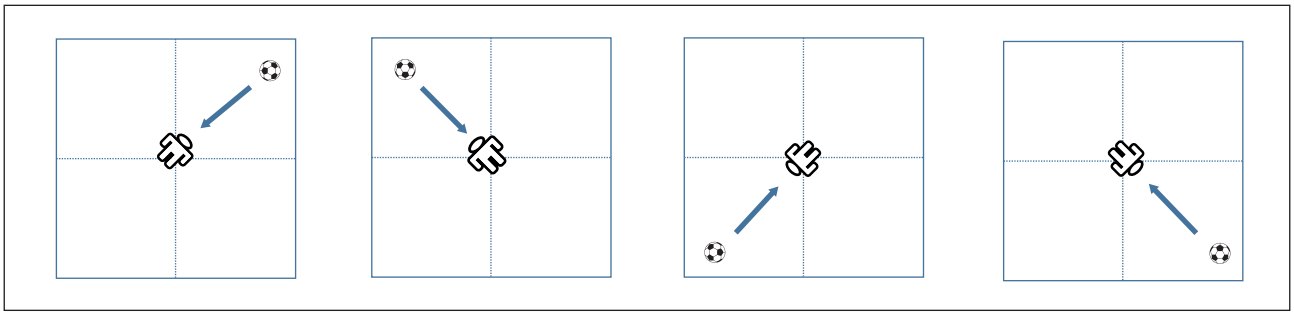
c) Statistically significant association relationships were detected with regard to categories of the incoming ball positioning and outgoing player positioning dimensions in the control actions performed by Sergio Busquets. In particular, the ball entering from the front (right-left) is significantly associated with an opposite front positioning (right-left) of the player on ball exit. This reinforces the statistically significant relationships of inhibition between incoming ball positioning and outgoing player positioning through the same front quadrant. These premises in the execution of the control action are in line with the previous paragraph concerning the relevance of control to afford continuity and intent to the game (Lago-Peñas & Dellal, 2010). It also reflects the way in which Sergio Busquets seeks to give width to the game (Castellano et al., 2013), playing the ball out on the opposite side to the one from which he receives it, thus respecting the football adage "the ball comes from one side and goes to the other". Equally, no significant activation relationships were detected when the ball enters through the rear quadrants, although there is an inhibition relationship, since when the ball enters through the rear left quadrant, Sergio Busquets plays it out through the front left quadrant.

d) Statistically significant association relationships were detected in control actions in which Sergio Busquets is positioned front-right when receiving (incoming body positioning) and has a front-left outgoing body positioning (in addition to an inhibition relationship on exit via the same quadrant). Similarly, the player is positioned on entry towards the front-left and his body has an outgoing positioning towards the front-right (and inhibition towards the front-left). These features of the control actions performed by Sergio Busquets dovetail with the function of linking control with the technical elements that bring continuity to the game, pursuing a specific idea of play in which the ball "enters from one side and exits through the other"; and in which the ball does not exit via the side from which it entered (Castelo, 1999; Hughes, 1990). The lesser association and inhibition relationships in the rear quadrant may be related to the fact that the player in these quadrants does not see the game "face-on" (i.e. the direction in which his team is attacking) and prioritises

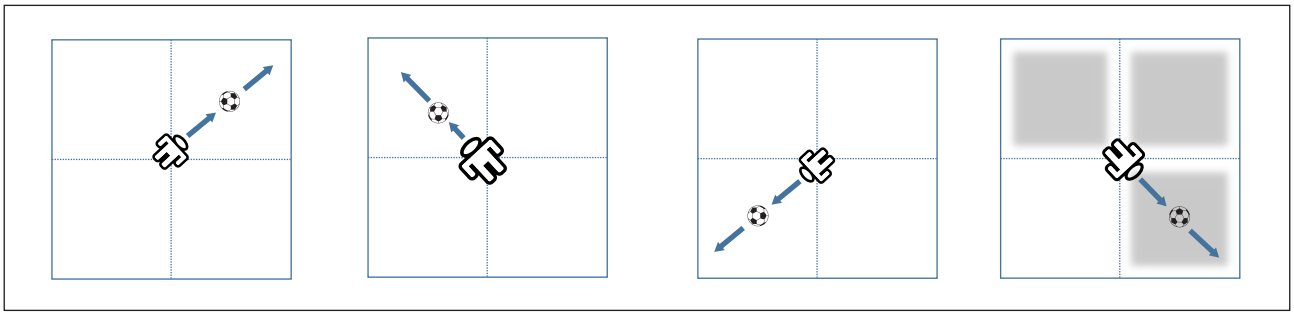
the intention to secure the ball (Serra-Olivares et al., 2017) in an area where possession runs the risk of becoming a threat if the ball is lost (Lago-Peñas & Dellal, 2010).

e) As for the influence of opponents in the centre of play of Sergio Busquets, a statistically significant association was detected with the fact that when sector 3 (FS3) is free, he plays the ball through the rear-right sector (BSTD) with the player also positioned towards the ball exit (JSTD). In other words, in the case of Busquets, control actions were found in which even though there are no opposing players in sector FS3, the player plays the ball through sector SL4. This situation is not ideal from a theoretical point of view and should be related to the results presented in which a significant statistical association is shown whereby when the ball enters via the rear quadrants, the ball enters from the left and exits to the right; in both cases, the player's positioning coincides with the ball's on both entry and exit (Figure 2). These results show how Sergio Busquets brings a tactical intent to the control element, i.e. to play out via the side opposite to the one from where the ball enters, despite the fact that the adjacent quadrant is free. This decision, derived from a defined idea of play (Sarmento, Marcelino et al., 2014), can be executed based on mastering the technical execution of the control core technical concept, which brings with it a corresponding feeling of competence (Weinberg & Gould, 2003).

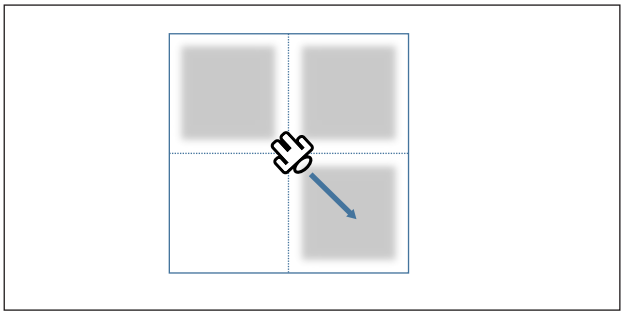
Figure 2
Chart of the statistically significant association relationships shown in Table 3



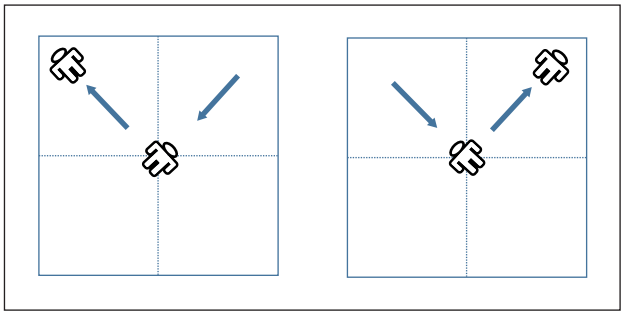
Incoming ball positioning control / Positioning of the player on ball entry in the control.



Outgoing ball positioning control / Positioning of the player on ball exit in the control and opponents in the centre of play (in grey, sectors occupied by opponents).



Positioning of the player on ball exit in the control / opponents in the centre of play.



Positioning of the player on ball entry in the control / Positioning of the player on ball exit in the control.

The T-patterns detected using the pre-set search parameters and requirements permit the classification of specific game sequences which include all the dimensions of the observation instrument. Specifically, the results shown in Table 4 provide information that is consistent with the role taken by Sergio Busquets at FC Barcelona (Maneiro & Amatria, 2018), demonstrating that this player performs control actions with the instep (IN) in the creation zones of his own half (Z50) and the opponents' half (Z51), and with him on the back line of his team with the front line of the opposing team (RAO) in front of him. In addition, the information contained in the T-patterns allows the following sequences to be classified, which also include the characteristics outlined above:

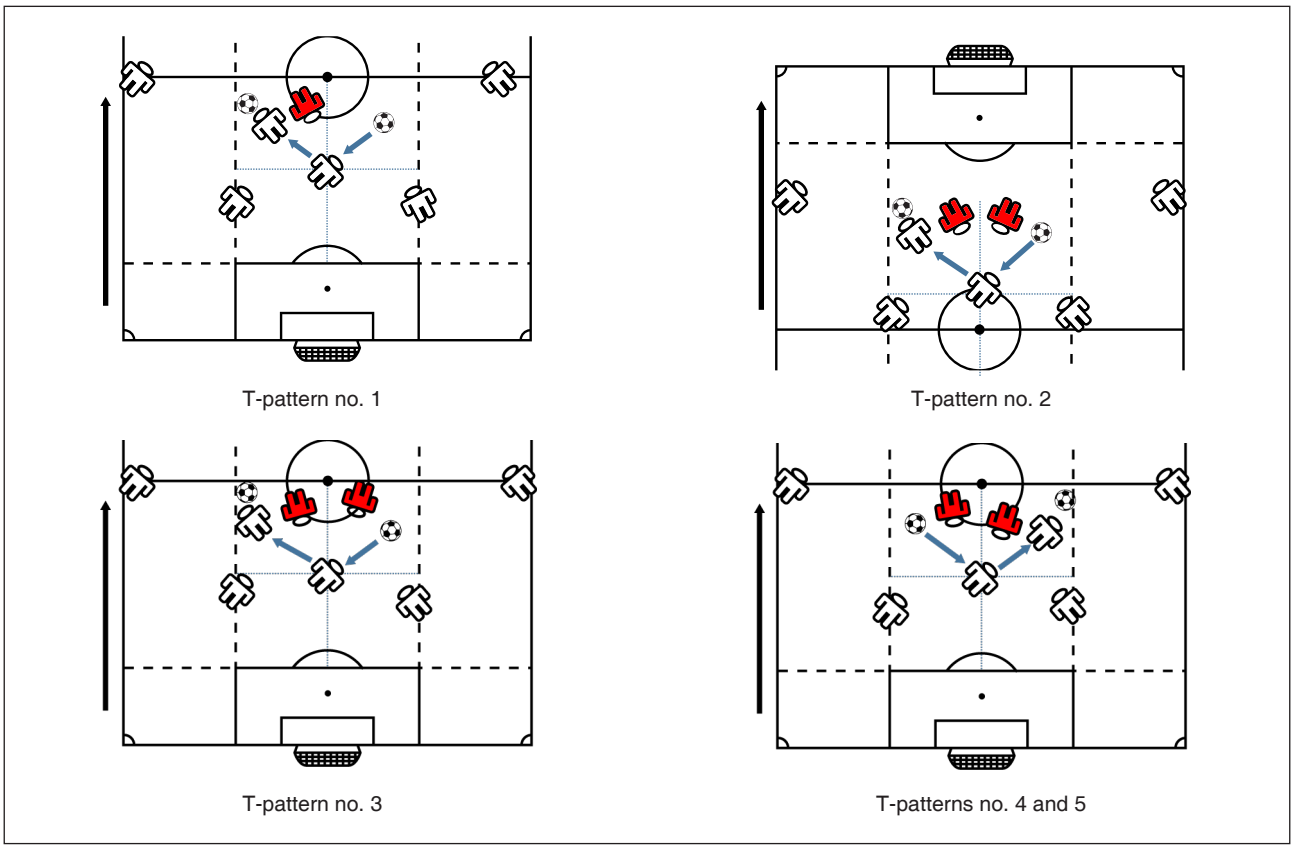
a) Sector 1 of the centre of play occupied (SO1) with the teams drawn, results in ball control with a front-right incoming ball and player positioning (BEAD) (JEAD) and an outgoing ball and player positioning towards the front-left (BSAI) (JSAI) (T-pattern with order number 1).

b) Sectors 1 and 2 of the centre of play occupied (SO12) with the teams drawn, results in ball control by Busquets with a front-right incoming positioning of both player and ball and a front-left outgoing positioning of both player and ball (T-patterns with order numbers 2 and 3).

c) Sectors 1 and 2 of the centre of play occupied (SO12) with the teams drawn or his team winning, results in ball control by Busquets with a front-left incoming positioning of both player and ball (BEAI) (JEAI) and a front-right outgoing positioning of both player and ball (JSAD) (BSAD) (T-patterns with order numbers 4 and 5).

The T-patterns detected support the results derived with the adjusted residuals analysis due to their coincidences, but also complement them based on the information potential of each cluster configuration detected (Amatria et al., 2016). All the game sequences that include Sergio Busquets' control reflected in the T-patterns coincide with the adjusted residuals analysis (sections a, b, c and d) in relation to the statistically significant association that when the ball enters via a front quadrant, the ball exits via the opposite quadrant; and that when the ball enters via the rear-left quadrant, it exits through the rear-right quadrant; in both cases, the player's positioning coincides with the ball's on both entry and exit (Figure 3).

Figure 3
Chart showing the information contained in the T-patterns detected shown in Table 4



The T-patterns also show that Sergio Busquets can impose the tactical sense of the game, exiting via a quadrant occupied by the rival team regardless of his lateral dominance (Guilherme et al., 2015); it shows the skill and competitive drive of a player currently considered one of best defensive midfielders on the international stage (Weinberg & Gould, 2003).

As a limitation of this paper, it should be noted that the technical/tactical performance in the game is conditioned by other contextual variables in addition to the score at the time in the game, such as playing at home or away, the quality of the opponent the team faces and the role of the player (Lago-Peñas & Dellal, 2010; Sarmento, Marcelino, et al, 2014; Taylor et al., 2008). Their interrelationship with the object of study described here is an appealing issue for further research which would also allow for a considerable increase in the observational sampling carried out.

This paper's conclusions are a highly significant starting point for designing tasks whose purpose is to develop the "control" core technical concept on the basis of analysis of a leading player. Task design should include a tactical intention which dovetails with each team's game idea.

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Quantification of Perceived Effort in Elite Young footballers Throughout a Season

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Abstract

Objective. To analyse the differences between the mean internal load via perceived effort (IL PE) recorded by elite young players throughout a season. *Methodology*. Nineteen Sub-19 footballers belonging to a professional club participated in the study. The players were classified into regulars and reserves. The competitive period was divided into 2 periods, 5 blocks and 30 micro-cycles *Results*. The IL PE was significantly higher during period 2 ($p < .01$; ES = 0.35; low) than during period 1 among the regulars. Furthermore, the IL PE recorded in block 3 was significantly lower ($p < .05$; ES = 0.79; moderate) than in block 5 in the regulars. Finally, significant differences were found in the IL PE of the different types of micro-cycles in both regulars and reserves ($p < .01$; ES = 0.68-1.94; moderate-high). *Conclusions*. The results show that the IL PE remains relatively stable throughout the season in young footballers; however, weekly results may vary according to the type of micro-cycle, bearing in mind the location of the previous and subsequent matches.

Keywords: timing, training load, subjective perception of effort, play time, football

Introduction

The timing of training is an essential strategy to improve footballers' performance throughout the season (Malone et al., 2018; Sparks et al., 2017). However, this is a complicated task given that a host of factors (technical-tactical, psychological and conditional) can influence the attainment of optimal performance. Nonetheless, it has been proven that accumulation of the weekly training load may be associated with an improvement in performance (Jaspers et al., 2017). Furthermore, it has been observed that an appropriate distribution of the load may reduce injury rate (Gabbett, 2016). Therefore, quantifying may be a useful strategy to ascertain the distribution of loads throughout the micro-cycles during the season.

Objective methods have been used to determine the training load in football, such as global positioning devices (GPS) (Malone et al., 2015), which provide information on physical parameters (total distance run, distance run at different speeds, number and magnitude of accelerations, decelerations and changes in direction), or heart rate (HR) monitors (Lacome et al., 2018), which provide information on HR (maximum HR, mean HR and time between different intensity zones). Furthermore, more subjective methods have been used, such as perceived effort (PE), which sheds light on the internal load (IL) recorded by the players. This tool is readily accessible, relatively easy to use and does not require excessive time to process the data (Los Arcos et al., 2014), in addition to having previously been validated for use with footballers (Impellizzeri et al., 2004). Despite this, few studies have used it to ascertain load distribution throughout the season (Los Arcos et al., 2017; Malone et al., 2015, 2018) and it would therefore be interesting to gain further knowledge of it in order to show the possible variations in PE stated by the players according to the different times in the season.

Ascertaining the distribution of IL through PE (IL PE) throughout the micro-cycles, blocks and periods of a season could be interesting in order to optimise training and apply specific recovery protocols at each point in the season. Some studies have shown that the IL PE remains relatively stable throughout the competitive period in senior footballers, with minor differences between periods (Los Arcos et al., 2017; Malone et al., 2015). However, research that addresses this aspect in young players is needed.

Therefore, the main objective of this study was to analyse the differences between the mean internal load via perceived effort (IL PE) recorded by elite young players throughout a season.

Methodology

Participants

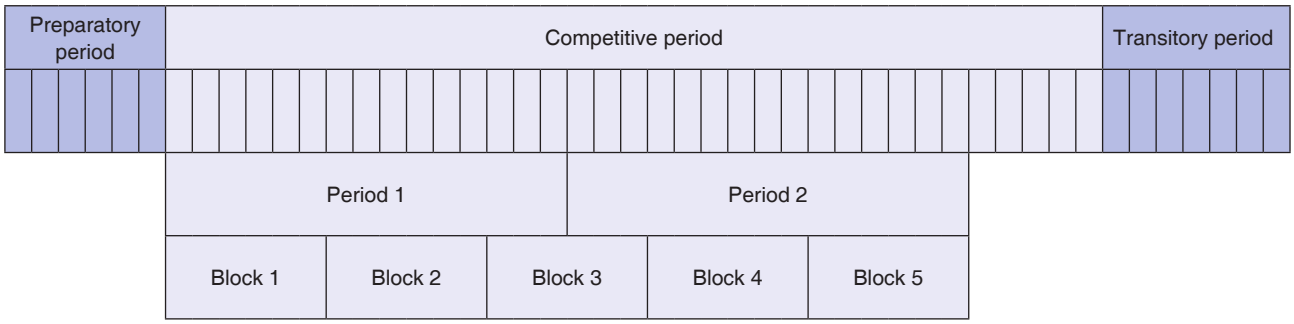
Nineteen elite young footballers (age: 18.5 ± 0.5; height: 178 ± 6 cm; weight: 72.1 ± 6.3 kg; body mass index (BMI) 21.8 ± 1.7 kg $\cdot$ m^{-2}) belonging to the same youth football team (Sub-19, with 5 ± 4 years of experience in the club) from a Second Division football club in Spain participated in this study. The players trained 4 times per week and played the official matches at weekends (Saturday or Sunday). The team comprised 3 goalkeepers, 7 defensive players, 8 midfielders and 4 forwards. The goalkeepers were excluded from the subsequent analyses due to their role in training and matches. Before starting the study, all the participants were informed of the research protocol and they all signed informed consent forms, as did the parents or legal guardians of players under the age of 18. The study followed the guidelines set forth in the Helsinki Declaration (World Medical Association, 2013), was approved by the Ethics Committee at the University Isabel I (CEI004) and was conducted following the ethical standards established for sport science and exercise research (Harriss & Atkinson, 2015).

Procedure

The declared PE of the players was collected for 120 sessions and 30 official matches in the 2016-2017 season (September-May). The players were classified into two groups: 1) regulars, those who started the match and played at least 45 minutes ($n = 291$ observations), and b) reserves, those who did not participate in the match or did so for less than 45 minutes ($n = 201$ observations). The season was divided into two parts: period 1 (first round of competition, 15 matches and 60 training sessions) and period 2 (second round of competition, 15 matches and 60 training sessions). Furthermore, each period was divided into five 6-week blocks, which in turn were broken down into 30 micro-cycles (Figure 1). The weeks when the team was not playing in official competition were excluded from the subsequent analyses (around Christmas), as were players who were not available for some of the training sessions.

With the goal of comparing the PE declared by the footballers between the micro-cycles, taking competition as the reference, four types of micro-cycles were recorded: 1) Saturday-Saturday (M1, 7-day micro-cycle, 6 cases); 2) Saturday-Sunday (M2, 8-day micro-cycle, 6 cases); c) Sunday-Saturday (M3, 6-day micro-cycle,

Figure 1
Experimental design scheme used in this study



5 cases); and 4) Sunday-Sunday (M4, 7-day micro-cycle, 13 cases). The distribution of the technical-tactical and conditional contents in each type of micro-cycle is shown in Table 1.

Mean internal load via perceived effort (IL PE)

The IL PE of the training was measured using the method used by Foster et al. (2001). Ten minutes after the end of each training session, each footballer was shown the RPE scale from 0-10 (Foster et al., 2001), and the player declared a value which was later multiplied by the total length of each training session. The players answered the question, "How hard was the training?", always asked by the same person (physical trainer of the team) (Los Arcos et al., 2017). The players declared their PE randomly, without the presence of their peers and with access to the values stated by their peers restricted. The players acquainted themselves with the use of the PE scale during the preparatory period. The length of the training was recorded individually from the start of the training session (including warm-up and recovery periods) until

Table 1
Distribution of the technical-tactical and conditional contents in each type of micro-cycle

	Previous match		Weekly trainings					Next match	
	SA	SU	M	T	W	TH	F	SA	SU
M1	M	D	Recovery and prevention (regulars) Compensatory work (reserves) (50-70 min)	R	PP and AP in a small space (75-90 min)	PP and PA in a medium-large space (75-90 min)	AP in a small space, SPM (50-60 min)	M	R
M2	M	D	Recovery and prevention (regulars) Compensatory work (reserves) (50-70 min)	R	PP and AP in a small space (75-90 min)	PP and PA in a medium-large space (75-90 min)	AP in a small space, SPM (60-70 min)	R	M
M3	R	P	Recovery and prevention (regulars) Compensatory work (reserves) (50-70 min)	R	PP and AP in a small space (75-90 min)	PP and PA in a medium-large space (75-90 min)	AP in a small space, SPM (50-60 min)	M	R
M4	R	P	Recovery and prevention (regulars) Compensatory work (reserves) (50-70 min)	R	PP and AP in a small space (75-90 min)	PP and PA in a medium-large space (75-90 min)	AP in a small space, SPM (60-70 min)	R	M

Note. M: match; R: rest; M1: Saturday-Saturday micro-cycle; M2: Saturday-Sunday micro-cycle; M3: Sunday-Saturday micro-cycle; M4: Sunday-Sunday micro-cycle; AP: actions performed; PP: position play; SPM: set-piece moves.

its end (excluding cool-down exercises), as in previous studies with elite young footballers (Los Arcos et al., 2017).

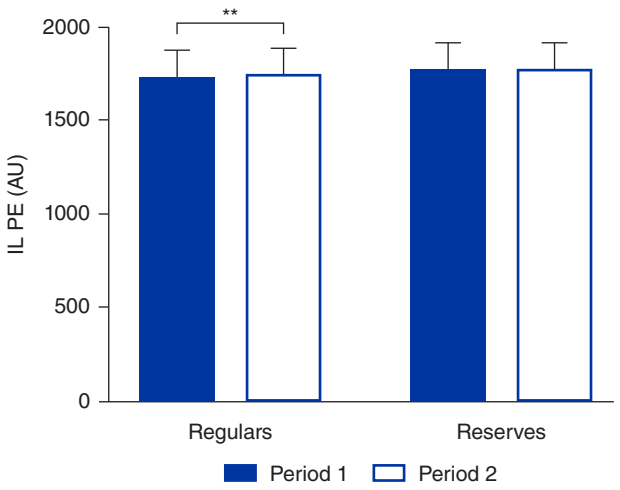
Statistical Analysis

The results are presented as mean ± standard deviation. A *t*-test for independent samples was used to compare the IL PE in different periods in the season between regulars and reserves. Furthermore, a repeated measures ANOVA was used with the post-hoc Bonferroni adjustment to compare the IL PE between the different parts of the season, as well as between the different kinds of micro-cycles (e.g., M1, M2, M3 and M4) independently for each group (regulars and reserves). In order to ascertain the magnitude of the differences for practical purposes, the effect size (ES) was calculated using Cohen's *d*-statistic, and its interpretation followed these criteria: trivial, under 0.2; low, between 0.2 and 0.5; moderate, between 0.5 and 0.8; high, higher than 0.8 (Cohen, 1988). The statistical analysis was performed with the *Statistical Package for Social Sciences* (SPSS® Inc, version 24.0 Chicago, IL, USA) software. The level of statistical significance was set at $p \leq .05$.

Results

The regulars recorded a similar IL PE during the training sessions (ES = 0.11; trivial) to what the reserves recorded (1785.00 ± 173.97 vs. 1765.86 ± 138.05 AU).

Figure 2
Mean internal load via perceived effort (IL PE) between periods 1 and 2 of the season in regulars and reserves

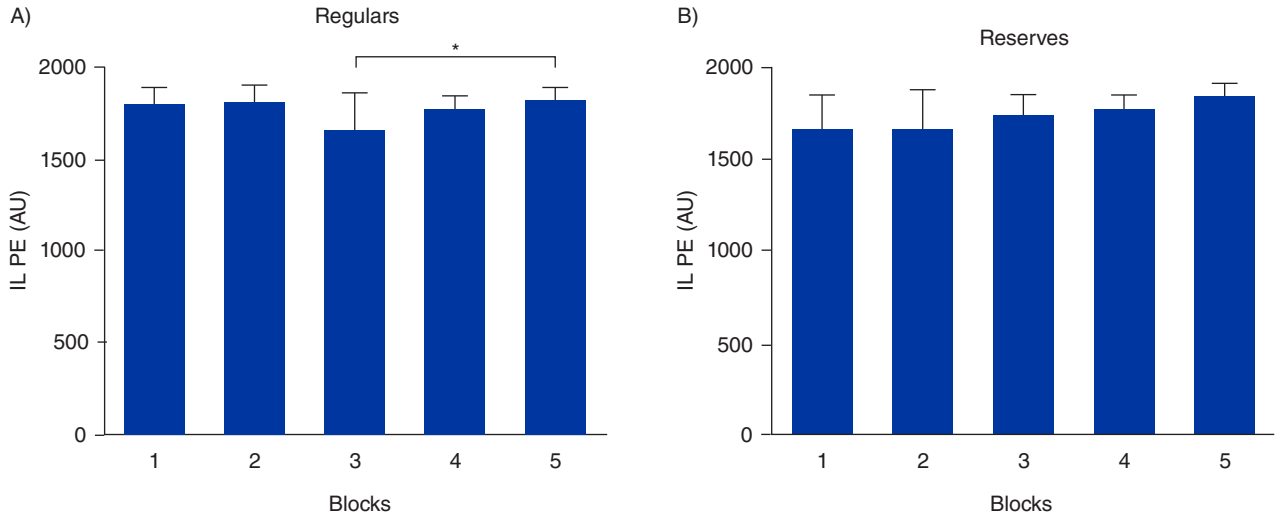


* Significant differences (p <.05); ** Significant differences (p <.01).

The IL PE recorded by the regulars was significantly higher ($p < .01$; ES = 0.35; low) in period 2 (1786.70 ± 136.51 AU) than in period 1 (1732.73 ± 153.03 AU). In contrast, these differences were not found in the reserves (ES = 0.22; low). Furthermore, no significant differences were found in the IL PE recorded by regulars and reserves in the periods analysed (Figure 2).

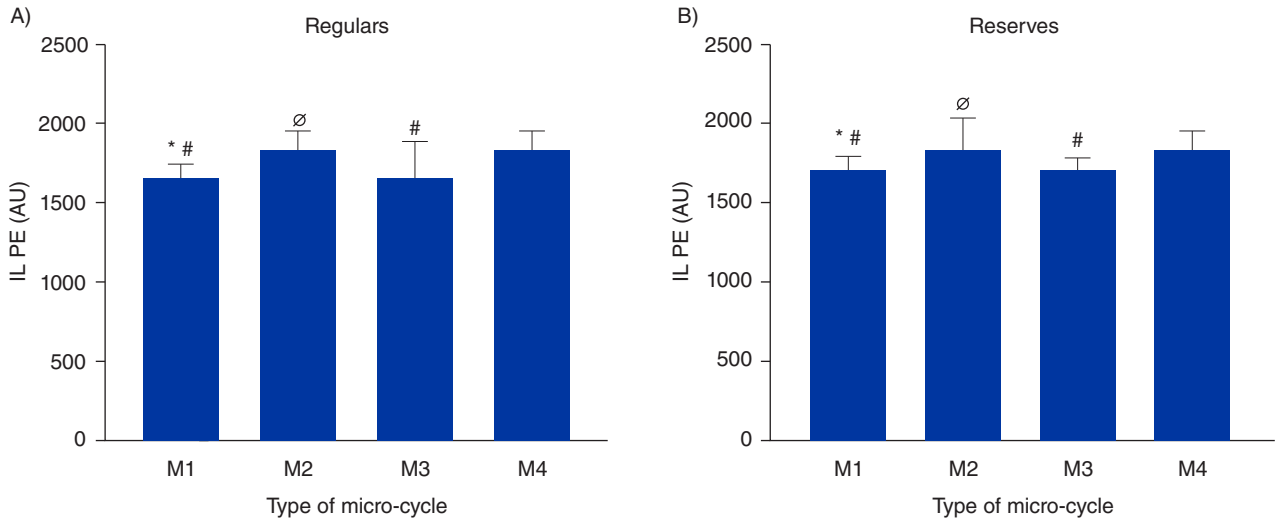
Figure 3 shows the IL PE recorded by the regulars and reserves during each competition block. The regulars recorded a higher IL PE in block 3 than in block 5 ($p < .05$; ES = 0.79; moderate). On the other hand,

Figure 3
Results of the mean internal load via perceived effort (IL PE) in each of the blocks of the season in regulars (A) and reserves (B)



* Significant differences (p <.05); ** Significant differences (p <.01).

Figure 4
Results of the mean internal load via perceived effort (IL PE) in each of the micro-cycles



Note. M1: Saturday-Saturday; M2: Saturday-Sunday; M3: Sunday-Saturday; M4: Sunday-Sunday in regulars (A) and reserves (B).
* Significant differences in the IL PE compared to micro-cycle 2 ($p < .01$); Ø Significant differences in the IL PE compared to micro-cycle 3 ($p < .01$); # Significant differences in the IL PE compared to micro-cycle 4 ($p < .01$).

no significant differences ($p < .05$) were found in the IL PE between the regulars and reserves in the competitive parts.

Figure 4 shows the IL PE recorded by the regulars and reserves in the different micro-cycles. The IL PE was significantly higher in M2 and M4 compared to M1 ($p < .01$; ES = 1.17-1.77; high), in M2 compared to M3 ($p < .01$; ES = 0.68-1.48; moderate-high) and in M4 compared to M3 ($p < .01$; ES = 0.76-1.94; moderate-high) for both regulars (Figure 4A) and reserves (Figure 4B).

Discussion

The objective of this study was to analyse the differences between the IL PE recorded by elite young players in the course of a season. The main results showed that: a) the IL PE recorded by regulars and reserves was similar; b) regulars declared a higher IL PE in period 2 of the season; c) the IL PE was higher in block 5 than in block 3 among the regulars; and d) the IL PE recorded in M2 and M4 was significantly higher than in M3 and M1.

Participating systematically in official competition allows players to maintain and even improve their physical condition level throughout the season (Silva et al., 2011). However, it has been proven that the physical condition of footballers who are not subjected to this stimulus (reserves or those not called up) may be negatively affected (Paraskevas & Hadjicharalambous, 2018). To counter this decrease and thus offset the effects of competition to which the reserves have not been exposed, one strategy commonly used by technical staff is applying compensatory work on the day after a match by the footballers who participated in the previous match for less than 45 minutes (Los Arcos et al., 2017); this was also done in our study by prescribing compensatory work. However, this study found no significant differences in the IL PE recorded by regulars and reserves in the periods, blocks and micro-cycles analysed. These results suggest that the post-match session did not fulfil its intended objectives and that therefore including new training strategies which can replicate the demands required in competition by reserves might be worthwhile.

With the goal of maintaining a high level of physical condition throughout the season, technical staff vary the distribution of training tasks to lower the IL in the second period of the season (Brito et al., 2016). Although the opposite might have been expected, this study found a higher IL PE ($p < .01$; ES = 0.35; low) during period 2 (1786.70 ± 136.51 AU) than period 1 (1732.73 ± 153.03 AU) in the regulars. This shows that cumulative fatigue over the season is associated with higher PE (Moalla et al., 2016). In this sense, it has been demonstrated that young footballers tolerate the same IL worse than senior footballers (Al Haddad et al., 2015), and our study specifically found a higher IL PE towards the end of the season in the

regulars. However, this difference was not found in the reserves, primarily because they had not accumulated the load of official matches, which has been proven to be higher than the micro-cycle (Los Arcos et al., 2017). Similarly, another influential factor seems to be that the compensatory sessions proposed for the reserves did not have the overload effect expected or at least did not replicate the demands of competition.

In terms of the IL PE recorded in each block, this study found no significant differences in either regulars or reserves except that a lower IL PE was recorded in part 3 than in part 5 among the regulars. In this sense, Malone et al. (2015) only found significant differences in the IL in the third block of the season, compared to the first one ($p < .01$, ES = 0.49). Other authors have also found this absence of variations in the IL in professional Sub-23 footballers (Los Arcos et al., 2017). These results seem to demonstrate the existence of a stable IL throughout the season in order to avoid major fluctuations in IL and consequently reduce the risk of injury in footballers (Gabbett, 2016).

Technical staff vary the distribution of IL throughout the season according to the previous and forthcoming fixture schedule in order to reach an optimal physical condition level in the players that guarantees optimal competition fitness (Los Arcos et al., 2017). In this sense, Azcárate et al. (2018) demonstrated that the length of the micro-cycle (e.g., 6-8 days) did not influence the IL PE recorded by footballers. In contrast, this study found significant differences in both regulars ($p < .01$; ES = 0.68-2.00; moderate-high) and reserves ($p < .01$; ES = 1.17-1.98; high) in the different types of micro-cycles analysed (Figure 4). More specifically, it found that the IL PE recorded in M2 (Saturday-Sunday) was significantly higher than in M3 (Sunday-Saturday) and M1 (Saturday-Saturday) for both regulars and reserves. These differences reported in both studies may be due primarily to the footballers' competitive level, since professional teams can adapt their weekly structure to competition, whereas in minor-league football, the training days are predetermined, so only the intensity of each training can be changed according to previous and forthcoming fixtures as a way of modulating training load.

Conclusions

The main results of this study showed a similar IL PE recorded in the regulars and reserves which does not vary substantially throughout the season, although a slightly higher IL PE is recorded in period 2, a moderately higher IL PE in block 5 than in block 5 for regulars, and a higher IL PE in the longer micro-cycles in both regulars and reserves. The results provide valuable information for technical staff who seek to improve the timing of training loads in football and thus optimise training strategies.

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SCIENTIFIC NOTES

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Kinematic Analysis of the Snatch Technique in High Performance Weightlifters

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Abstract

The overall objective of this work is to compare the differences between the execution of snatches performed by high-performance male and female weightlifters as well as the lateral symmetry of the gesture through the 2D reconstructions of the kinematics. Seventeen weightlifters (6 women and 11 men) from "Liga Antioqueña de Levantamiento de Pesas" participated in this study. Their movements were captured in the frontal and sagittal plane by means of 2D videogrammetry. The articular kinematics of both men and women present the same bilateral symmetry. However, the transition and turnover phases exhibited the most significant changes. Differences between the two study groups can be found in their joint movement range, barbell vertical velocity, and base of support; the latter two were greater in women. This changes can be useful to provide coaches with basic biomechanical tools to improve their practice and to personalize training.

Keywords: weightlifting, snatch, videogrammetry, biomechanics

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Introduction

Lifting weights in the snatch mode must be continuous and fast, attached to the body and is allowed to slide the bar over of thighs. At the end of it, the athlete must remain stationary, with both arms and legs in extended position, the feet parallel to the plane of the trunk and the bar. The lifting in snatch mode is invalid if the lifting is made slowly, or if the athlete's head touches the bar (Zamora et al., 2015). Due to weightlifting current popularity, the methods to evaluate the techniques employed in the execution of the characteristic movements of the sport should be expanded and improved (Milanese et al., 2017). The fields of biomechanics and motion analysis provide coaches with tools to determine an adequate and objective training program for each specific athlete, thus supporting processes that have traditionally been guided in a subjective and empirical way (Salgado & Morales, 2014).

In the literature, most data acquisition methods for the technical analysis of the snatch gesture in weightlifting have focused on the kinematics of the barbell (Campos et al., 2009) and the angular kinematics of the joints (Akkus, 2012). There are also two-dimensional methods (Whitehead et al., 2014) and literature reviews (Ball & Weidman, 2018; Ho et al., 2014) that take into account variables such as gender, age, and weight category (Zamora et al., 2015), mainly in high-performance athletes (Hirunrat & Ruktawee, 2012). Nevertheless, few studies have combined variables that consider the barbell as well as the weightlifter in their analyses, which suggests the need for a more thorough approach that integrates barbell and weightlifter data to improve the mechanical understanding of a successful snatch (Ho et al., 2014).

The overall objective of this work is to produce 2D reconstructions of the kinematics of snatches performed by regional high-performance male and female weightlifters and quantitatively compare their executions in order to provide athletes with basic biomechanical insight to improve their practice and training.

Methodology

Subjects

A total of 17 weightlifters from Liga Antioqueña de Levantamiento de Pesas (Antioquia Weightlifting League) participated in this study. They included 6 women (average age: 17.9 ± 3.3 years, height: 1.67 ± 0.1 m, weight: 67.9 ± 1.5 kg, and experience in the sport: 5.5 ± 2.4 years) and 11 men (average age: 20.1 ± 3.8 years, height: 1.7 ± 0.1 m, weight: 88.7 ± 2.1 kg, and experience in the sport: 4.2 ± 2.5 years).

Before their voluntary participation, they signed an informed consent approved by the Ethics Committee of Instituto Tecnológico Metropolitano, which observes the principles established in the Declaration of Helsinki (DoH), as recommended by the World Medical Association (2013).

Variables and Instruments

A Basler acA640-120gc (Basler AG, Ahrensburg, Germany) three-camera system, with a 658x492 pixel resolution at a frequency of 60 fps and a gain of 100, was used to capture the movements. The cameras were synchronized by the software Templo 8.2.358. Additionally, Vicon Motus 10.0 was used to analyze the videos. Two-dimensional spatial modeling was performed to reconstruct the geometry of the weightlifters in the anterior frontal plane and the right and left sagittal planes using fourteen reflective markers placed on bony landmarks (Villa Moreno et al., 2008) (see Figure 1).

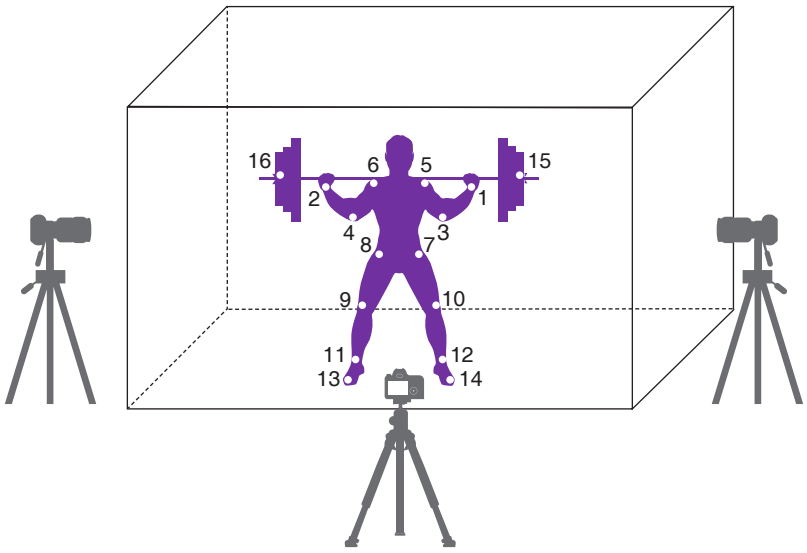
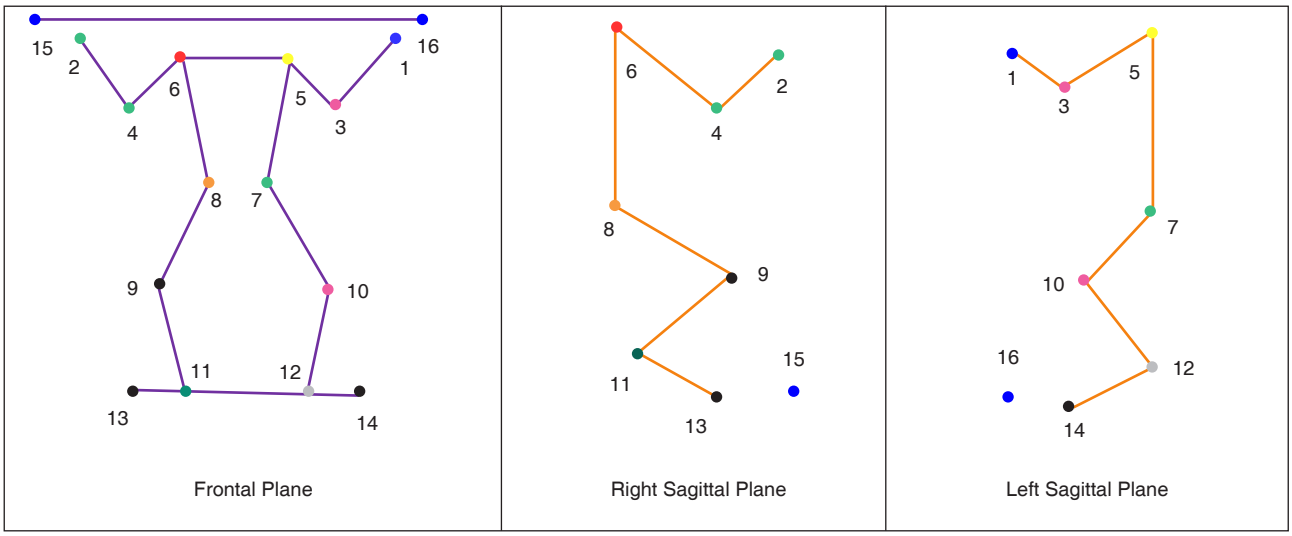


Figure 1
Placement of the reflective markers and spatial distribution of the cameras

Figure 2
Spatial models



Procedures

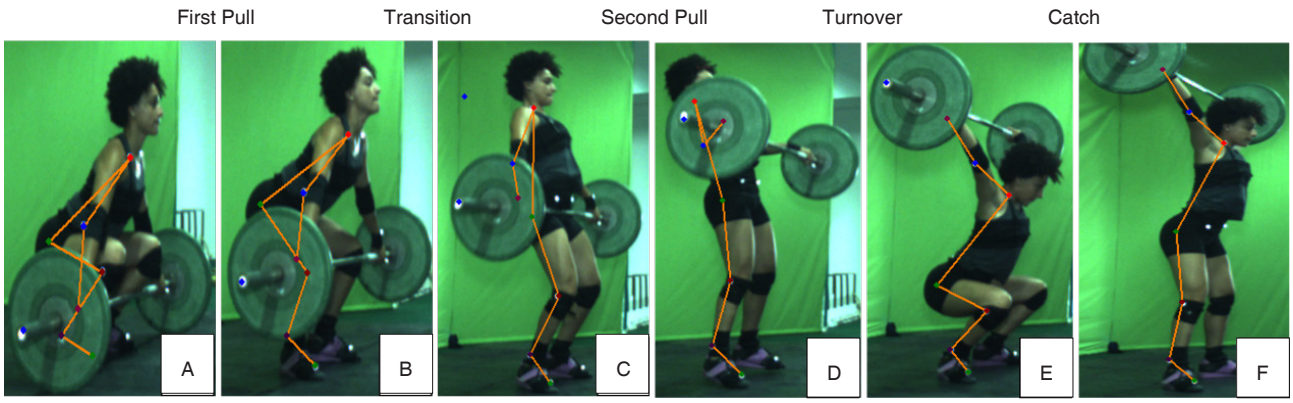
After they completed their specific warm-up, the athletes were instructed to perform a minimum of three snatches using the same positions they would in a competition. As per the coach's instructions, women lifted 35 kg and men, 50 kg. Multiple variables were studied in this work: hip, knee, and ankle angles in the sagittal plane, shoulder angle in the frontal plane, barbell vertical velocity, and the relationship between the base of support and shoulder width. Such variables were obtained from the design of the spatial model of each of the planes considering the markers on the athletes, in addition to their height and weight, to find the inertial parameters of each body segment and locate their center of mass, which is necessary for the 2D reconstruction of the sports gesture. (See Figure 2)

The gesture was divided into 5 phases defined visually by the change in knee angle and barbell height (Gourgoulis et al., 2015; Ho et al., 2014). The first pull starts when the barbell is lifted from the ground, and it is completed when the bar is at knee level. The transition begins when the knees change from extension to flexion and the bar reaches hip height. The second pull is a rapid coordinated extension of the hips and knees. During the turnover, the weightlifter quickly moves the body downward and stands under the bar to adopt the catching position. Finally, the snatch is completed by rising from the squat position (see Figure 3).

Statistical analysis

The statistical software Rstudio Version 1.2.1335 was used to treat the data obtained. The Shapiro–Wilk test was applied to determine normality with a .05 significance level, and the data were compared with the Wilcoxon signed-rank test. Also a descriptive analysis was conducted by means of box-and-whisker plots.

Figure 3
Phases of snatch: A) start position, B) bar at knee level, C) power position, D) triple extension, E) turnover, and F) catch



Results

The result of the Shapiro–Wilk test was $p > .05$, which indicates that the data present non-normality. Thus, a Wilcoxon signed-rank test was conducted showing significant difference in all variables except between right and left knee and shoulders in men (see Table 1).

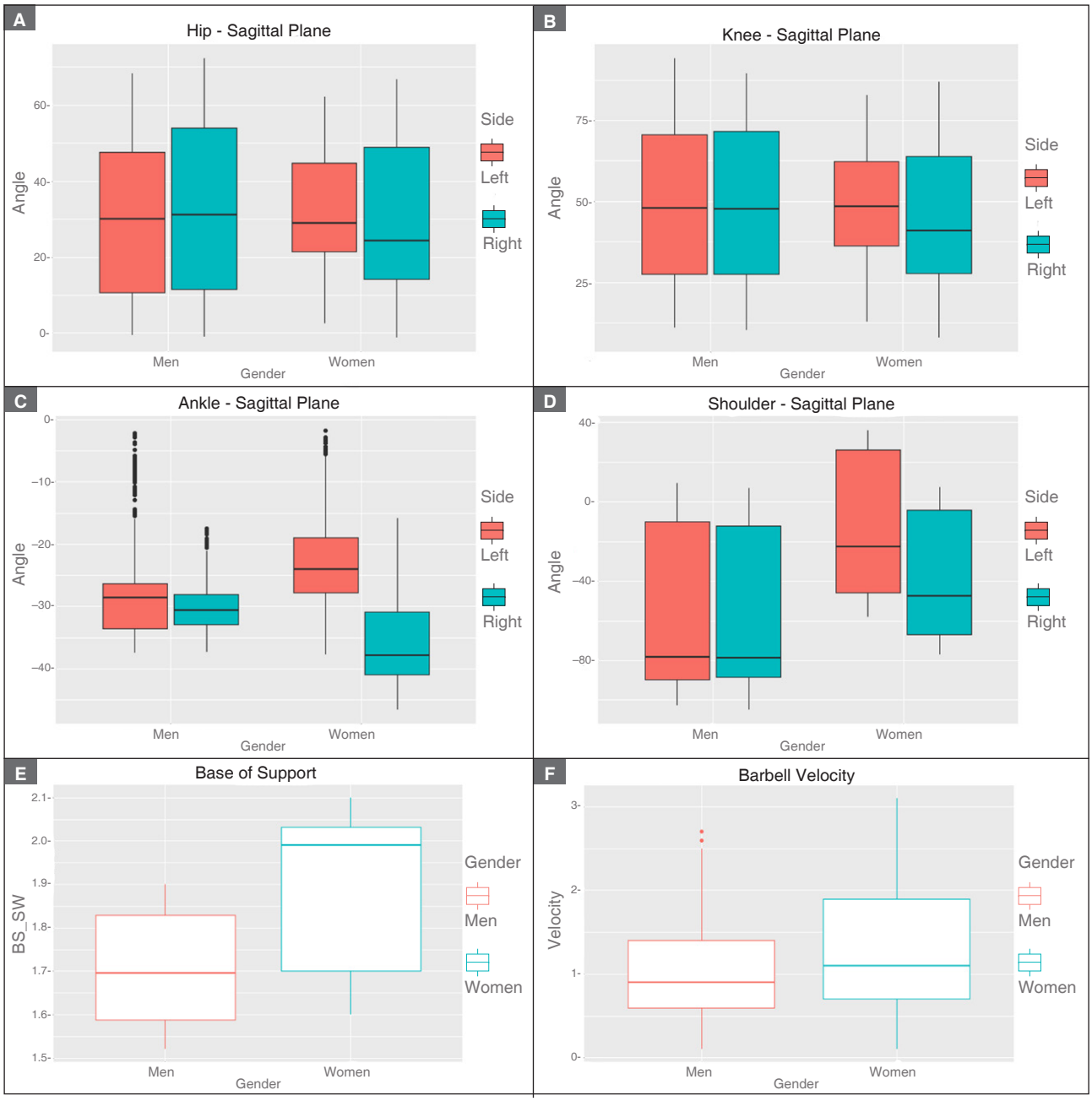
The descriptive statistics showed that the medians of the hip and knee angles intersubject are similar in both study groups, and the right side of women presented the highest variation. Men exhibit a closer relationship and dispersion of the data between the right and left limbs compared to women (see Figure 4*A* and *B*).

Table 1
Wilcoxon Signed- Rank Test p-value

Joint	Men vs. Women	Bilateral Men	Bilateral Women
Hip	0.0080	$< 2.2 \cdot 10^{-16}$	0.0094
Knee	$2.5 \cdot 10^{-2}$	0.8296	0.0002
Ankle	0.0007	0.0021	$< 2.2 \cdot 10^{-16}$
Shoulder	$< 2.2 \cdot 10^{-16}$	0.2640	$< 2.2 \cdot 10^{-16}$
Base of Support	$< 2.2 \cdot 10^{-16}$	NA	NA
Velocity	$1.87 \cdot 10^{-02}$	NA	NA

The medians of ankle angle are not related to gender; however, men present less data dispersion and a better relationship between the medians of the right and left side.

Figure 4
Box-and-whisker plots: A) hip, B) knee, C) ankle, and D) shoulder E) Base of support-shoulder width relationship, F) Barbell velocity

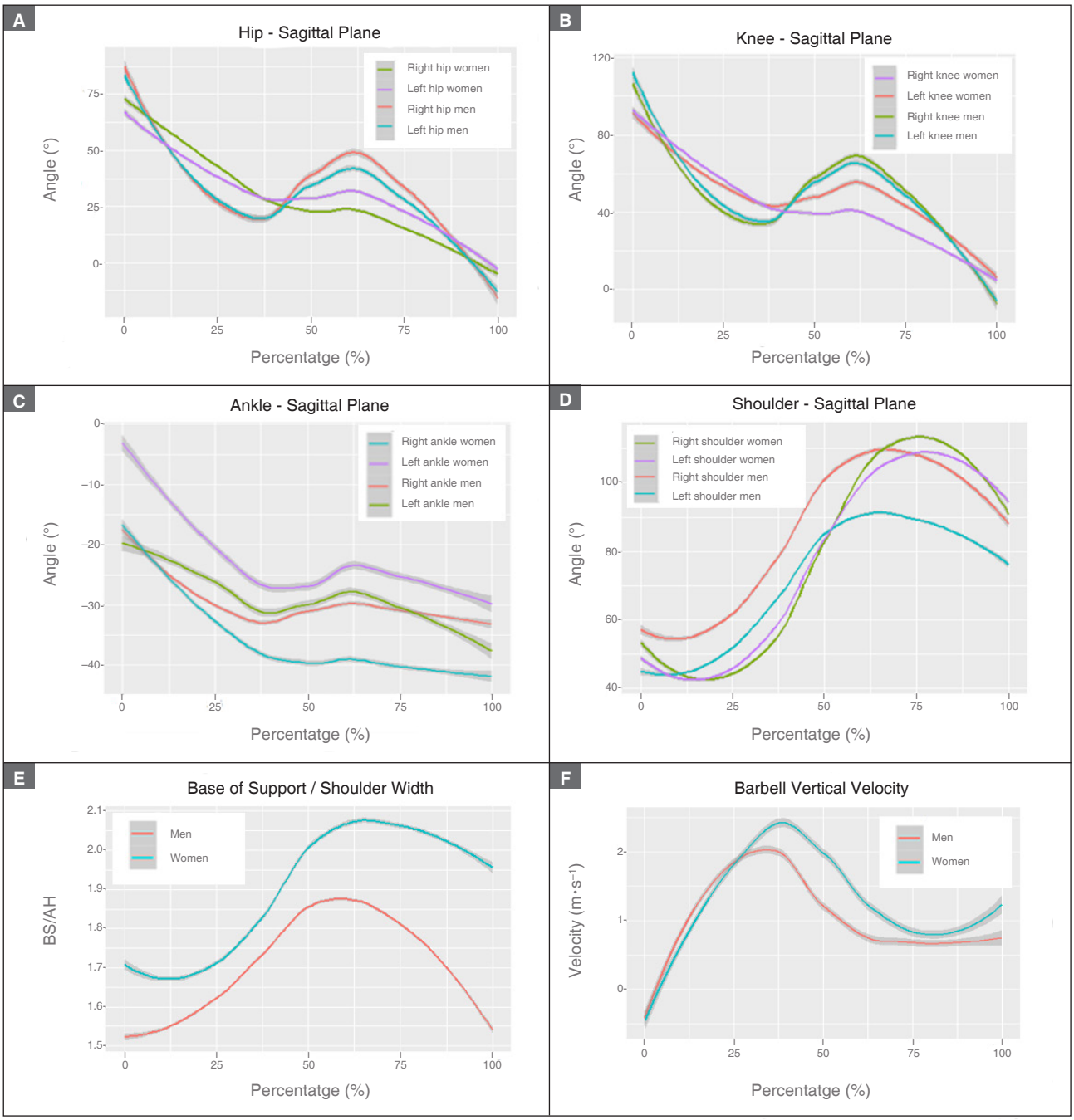


In the case of women, similarity between the angles of the right and left ankles was not observed, and a greater standard deviation was evident. No significant relationship was observed between the medians of men's shoulder angles in the frontal right and left planes; on the contrary, in women, the behavior is similar in the two planes (see Figure 4*C* and *D*).

The base of support presents a more dispersion in women than men, with no similarities between the medians of both genders (see Figure 4*E*). The vertical velocity of the barbell exhibits more disperse values and higher standard deviation in women. However, the medians are comparable in both study groups (see Figure 4F).

The analysis of the joint kinematics in the sagittal plane showed that the hip and the knee describe a bilateral movement similar in both genders during all the phases. Such joints start in a flexed position and are progressively extended until they reach an extension peak during the transition phase and a flexion peak during the turnover phase. The gesture is completed with the catch phase, when both joints are fully extended, except for women's knees (see Figure 5 *A* and *B*).

Figure 5
Joint kinematics: A) hip, B) knee, C) ankle, and D) shoulder, E) Relationship between normalized base of support and shoulder width, F) Vertical velocity of the barbell



The ankles have a similar pattern in both genders: they start in a dorsiflexion and are gradually extended to reach the plantar flexion peak during the transition phase; another light dorsiflexion appears during the turnover, and the gesture is completed with a maximum plantar flexion (see Figure 5*C*). The shoulder starts with a light abduction that continues throughout the gesture until it reaches its maximum peak during the turnover phrase; subsequently, it is adducted to complete the gesture (see Figure 5*D*).

The base of support during the turnover phase is slightly larger in women (see Figure 5*E*). The linear velocity of the barbell reaches its maximum peak in the transition phase (see Figure 5*F*).

Discussion and Conclusions

The most important changes in the joint angles occurred at the end of the transition phase and between the second pull and the turnover. The latter two phases are greatly important because, during the first one, enough power and momentum must be generated to lift the barbell, and, during the second, three joints are extended to lift said bar above the head (Akkus, 2012; DiSanto et al., 2015; Gourgoulis et al., 2015).

The maximum peak angles of the hip and knee are more pronounced in men. This could be related to their flexibility and training technique because the biomechanics of said joints, when men perform the gesture, are closer to values reported in other studies (Harbili, 2012). The ankles present the greatest variation in both study groups, which is possibly due to the type of footwear the athletes wore; some of them had a sole thicker at the heel and, as a result, their joints had a tendency to plantar flexion. In addition, the angle of the camera could have affected the results (Fortenbaugh et al., 2010; Sato et al., 2012).

It can be seen that the base of support is always greater than the shoulder width, and it increases until almost double during the turnover phase. Taking into account that the base of support is closely related to the stability of the posture, it has been shown that weightlifters must compensate to stabilize their center of mass and correctly place the bar above their heads without losing balance (Ho et al., 2011; Milanese et al., 2017). Furthermore, the linear velocity of the barbell is slightly higher in women, possibly because they lifted less weight and, during the turnover phase, the flexion they performed was not as pronounced as that of men (Harbili, 2012).

Thanks to the study of the biomechanical variables above by means of videogrammetry, the kinematics of the snatch techniques of weightlifters could be analyzed. Such analysis is a contribution for coaches, so that they guide their practice in an objective and customized manner, with better skills to analyze their athletes' performance. Thus, coaches can make changes to develop more effective training programs and promote a more efficient snatch technique among their athletes, thus improving their performance.

Although a standard weight for every athlete was implemented due to belonging at the same weight category it would be interesting to replicate the analysis with a percentage of their personal best or of their own weight in further studies to see if results change significantly.

Nevertheless, as this analysis was conducted in two dimensions only, the kinematic data are vulnerable to error. For that reason, the authors suggest the use of other techniques, such as non-magnetic inertial sensors, to study sports gestures as complex as those in weightlifting, which exhibit joint movement in multiple planes, being easier to implement for coaches and sport related people because it not depends on the camera setup to minimize parallax error (Sato et al., 2009).

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SCIENTIFIC NOTES

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Comparing the Most Demanding Passages of Official Matches and Training Drills in Elite Roller Hockey

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Abstract

The aim of this research was to identify and compare the most demanding passages (MDP) in elite roller hockey in competition and in different training situations. Data were collected using WIMU PRO™ sensors with inertial micro-technology and ultra-wide band positioning. Eight professional roller hockey players from the Spanish First Division League (Ok Liga) were analysed during the 2017-2018 season. The MDP were studied using a rolling average method in which maximal values were calculated for three different time windows (1', 2' and 5') in official matches and in four different training drills commonly used in the weekly team-training schedule: practice match (TRAINING MATCH), 4 vs. 4 in half court and one transition (4vs4+1T), 4 vs. 4 in half court and two transitions (4vs4+2T) and 3 vs. 2 wave transition drill (3vs2). The variable used for the comparison was the distance covered in high speed skating (HSS: >18 $km \cdot h^{-1}$; $m \cdot min^{-1}$) and only the maximum value of each player, drill and time window were stored for the study. The results show that training drills could not reproduce the maximum conditional effort that occurs in an official match in any time window. Moreover, all the situations and games analysed had higher levels of effort as the time of the window studied decreased. The analysis of shorter time windows could be a topic for future research. In conclusion, the findings of this study pave the way for future research into the identification and comparison of the most demanding scenarios in elite roller hockey that may help coaches to design training situations.

Keywords: external load, UWB, roller hockey, most demanding passage, team sports.

Introduction

The intermittent pace of team-sport games involves a set of actions and stimuli within a time range in which conditional demands are greater than other moments. These brief time periods are called Most Demanding Passages (MDP). An MDP may be described as a multifactorial phenomenon which occurs within a defined time period, when all the conditional and emotional variables will be more demanding as opposed to the other moments inside a game or training session.

The MDP of matches or drills has been analysed using different techniques (Martín-García et al., 2018), dividing matches into different quarters (Morencos et al., 2019) or dividing matches into parts of 15 minutes to 5 minutes, since, as the parts analysed were smaller, higher demands were placed on the players (Malone et al., 2017; Young et al., 2019). However, the rolling average seemed to be the most appropriate method for describing these scenarios (Delaney et al., 2017), since results constitute a good tool for designing training tasks (Campos-Vázquez & Lapuente-Sagarra, 2018).

Although there are numerous descriptive studies in different team sports, hitherto, research into conditional demands in roller hockey has been somewhat scant. Only few studies were found (Fernández-Raventós et al., 2019; Merino Tantiña et al., 2014; Trabal et al., 2020) and the clearest conclusions reached in the descriptive papers was that there were no significant differences between player positions. For this reason, the objective of this research was to identify the MDP in competition and in training tasks (without making any distinction between player positions) and to ascertain whether training drills could simulate match MDP.

Methodology

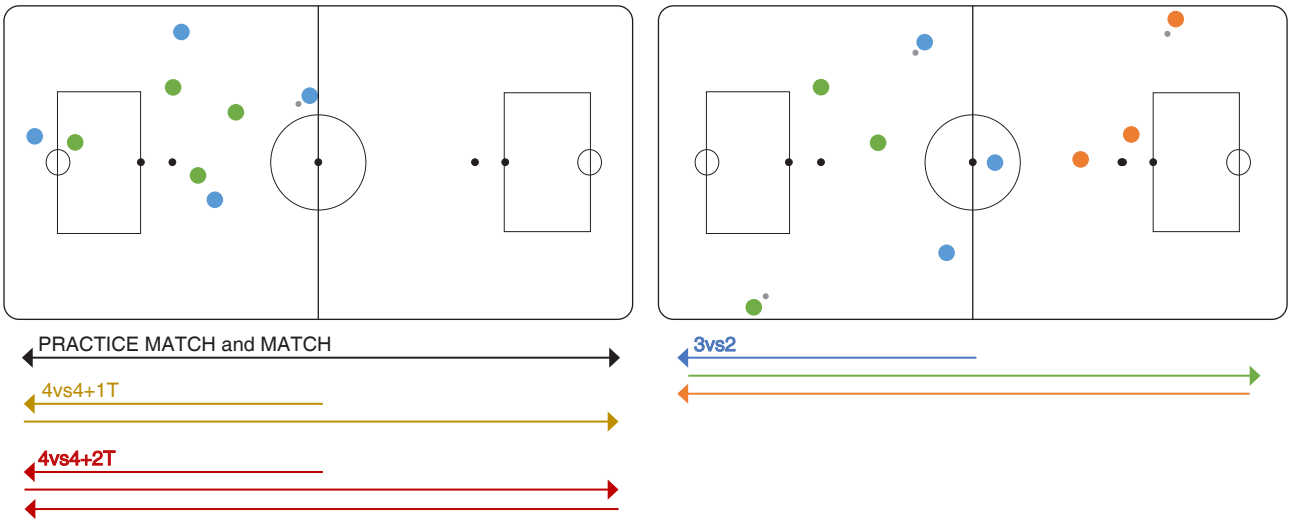
A retrospective observational study was performed during the 2017-2018 season. Positional data were collected with a wideband local system (UWB, WIMU PRO, Realtrack Systems SL, Almeria, Spain) for the subsequent determination of the MDP through the distance covered in high-speed skating (HSS: >18 km·h^{-1}, m·min^{-1}) during official games (MATCH), and also in different training drills (Figure 1) that are common in the training schedule of the team in question: (I) a 4 vs. 4 match played under formal game rules (TRAINING MATCH), (II) a half-court 4 vs. 4 scrimmage with a full-court transition by the defending team (4vs4+1T), (III) a half-court 4 vs. 4 scrimmage with a full-court double transition (4vs4+2T), and finally (IV) a 3 vs. 2 wave-transition drill in full court (3vs2). A non-experimental descriptive method was used to find the differences between the training drills and the match.

Eight professional male roller hockey players (age: 29.6 ± 5 years, weight: 78.1 ± 4.6 kg, height: 178.8 ± 3.1 cm) from the Spanish First Division (Ok Liga) participated voluntarily in the study. No goalkeepers were included. During the study, the team trained for 4 or 5 days and played between 1 or 2 games a week. A total of 886 individual records were obtained. The distribution of records in each training drill format is shown in Table 1.

Table 1
Number of records in each drill and competitive matches according to the time window analysed

Time Windows	MATCH	TRAINING MATCH	4vs4+1T	4vs4+2T	3vs2	Total
1'	55	75	65	53	75	323
2'	55	75	65	53	75	323
5'	55	75	57	53	–	240

Figure 1
Schematic representation of the four drills analysed and the competition match



The tasks analysed always correspond to sessions held three or four days before the match, and the data analysed were taken from the daily supervision of the player, hence no approval of an ethics committee was required. Nevertheless, this study was conducted in accordance with the Helsinki Declaration and the players gave their written consent before participating. The logging devices were located in the upper part of the back on tight vests. The data collected were analysed with computer software (SPRO, RealTrack Systems SL, version 946). The WIMU PRO™ sensors are equipped with three different inertial sensors: accelerometer, gyroscope and magnetometer, a GPS (10 Hz sample frequency), and a UWB (18 Hz sample frequency). The WIMU PRO™ presented both good/acceptable accuracy and inter- and intra-unit reliability for UWB positioning (Bastida Castillo et al., 2019)

To identify the MDP, the HSS variable of the different training drills and match was computed for each player using the rolling average method in 3 different time windows (1', 2' and 5'), the most common durations of the training tasks. The results were always expressed as the mean plus standard deviation (mean ± SD), and only the maximum value obtained for each player, location and time window was recorded.

A Kolmogorov-Smirnov (K-S) normality test indicated that all the drill data were not normally distributed, and a Wilcoxon rank sum test was therefore conducted to evaluate possible differences between drills in the same time windows. The entire statistical analysis was performed using RStudio version 1.1.463 (RStudio, Inc.) for Windows version 10 Pro, with significance being $p < .05$.

Results

Table 2 displays all the mean values and SD of each drill in the three different time conditions. The results show that the MATCH MDP is much more demanding than the other MDP analysed in all time windows, with clearly significant differences. Moreover, and for all time windows, TRAINING MATCH and 4vs4+2T MDP presented no significant differences between each other and for the windows of 1' and 2' TRAINING MATCH, neither did 3vs2 MDP present significant differences.

The 4vs4+1T drill presented fewest meters covered in the three time conditions and exhibited significant differences with all the other drills analysed.

Table 2
Mean relative values ± SD (in m · min^{-1}) of the HSS variable in the drills and competitive matches

Time Windows	MATCH	TRAINING MATCH	4vs4+1T	4vs4+2T	3vs2
1'	78.42 ± 19.89^{ABCD}	49.98 ± 16.52^{B}	40.42 ± 13.94^{CD}	46.94 ± 19.61^{D}	50.76 ± 17.56
2'	54.57 ± 15.18^{ABCD}	32.46 ± 12.15^{B}	27.81 ± 8.66^{CD}	36.43 ± 10.14^{D}	37.37 ± 13.55
5'	33.14 ± 7.91^{ABC}	21.20 ± 7.92^{B}	18.38 ± 5.90^{C}	23.93 ± 7.02	

A: TRAINING MATCH; B: 4vs4+1T; C: 4vs4+2T; D: 3vs2; $p > .05$.

Conclusions

The purpose of this study was to identify the MDP in competition and in training drills and to compare them to find differences between them. The main findings were: (I) none of the training situations was capable of reproducing MDP MATCH demands; (II) all the drills analysed had more intense MDP when the time window was shorter and (III) TRAINING MATCH, 4vs4+2T and 3vs2 presented no differences with each other and similar MDP demands.

According to other research (Martín-García et al., 2018), most (not all) of the training games used in a weekly soccer schedule did not reach the high-speed running distances covered in official-match MDP, only the one with the largest team (10 vs. 10). The results suggest that the drills we analysed cannot reproduce match MDP, which may suggest that we chose the most common drills in the weekly microcycle and not the ones that seek to replicate the MDP of HSS in matches. It may also suggest that the variable analysed was not the most suitable one for the study of MDP in roller hockey, since it transpired that high-speed movement may be maintained through the use of inertia from a previous effort and not through the player's continual effort (Fernández-Raventós et al., 2019). It would be interesting to analyse other conditional variables related to high-intensity actions such as accelerations, decelerations or player load to complement the MDP information.

The results of this study pave the way for future research into the identification of MDS in professional roller hockey and may help coaches to design training drills with different physical conditioning finalities, adapting these requirements to the specific durations of the drills.

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Safety in Sports Facilities from the Standpoint of the Sports Manager: The Case of Heated Swimming Pools for Collective Use

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Abstract

This study examines the issue of safety in sports facilities from the standpoint of sports management and focuses on the particular case of indoor heated swimming pools for collective use. Sports management encompasses and unifies multiple spheres of action. However, safety-related aspects in sports facilities tend to be addressed from the standpoint of each safety expert, while studies from the perspective of the actual world of sports are in the minority. For this reason, we conducted a set of studies on this topic. As the topic is new, the first study is exploratory and qualitative: a document review covering a broad spectrum of documents in the field of safety in sports facilities (463 documents of different types: legislative, technical regulations, research, professional documents and specific topics) and lays the groundwork for subsequent studies. Notations and a classification table were created specifically. The study reaches conclusions attesting to the broad regulatory and informational dispersion, the division of professional disciplines into types and the lack of a consolidated corpus of research-based knowledge. The following four studies are descriptive and quantitative. The first one focuses on indoor swimming pools for collective use, and a tool to analyse safety and accessibility (a validation questionnaire or checklist) for both investigational and professional use is developed and validated. This this tool was then used to conduct a study on a clearly-defined set of facilities. The previous results were subsequently complemented with a study on swimming pool users' perception of safety, to which end a perception questionnaire was developed and validated. The studies performed conclude with the development of a safety indicator based on the tools used. The purpose of this doctoral thesis is general, although the scope of the study focused on heated municipal swimming pools for collective use in the Autonomous Community of the Region of Murcia, presenting a ranking of these facilities based on the studies conducted.

Keywords: sports management, sport, safety, sports facilities, heated swimming pools, perception of safety

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Effects of Practising the Pilates Method on Psychosocial Health

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Abstract

The main objective of this thesis is to analyse the levels of psychosocial and health in the workplace recorded by Pilates practitioners and non-practitioners and their evolution over six months. The total study sample was comprised of 212 participants divided into two groups: Pilates practitioners and non-practitioners. The study is longitudinal via two repeated measures: initial assessment and final assessment. Furthermore, a set of four identical questionnaires with psychosocial status variables was distributed each month between the initial and final assessment. The results show that the Pilates practitioners receive more social support at work and relate more to physical exercise than the non-Pilates group. Furthermore, after practising for five or more months, higher levels of self-concept and identification with physical exercise are found in the Pilates practitioners than in other more inexperienced individuals. After six months of follow-up, the depressive symptomology of Pilates practitioners improved. Conversely, the sedentary persons in the control group presented higher levels of workplace tension and self-concept, and their levels of control, absorption and dedication to work diminish. Status variables were assessed on a monthly basis, and the Pilates practitioners were found to have *lower levels of negative feelings* and anxiety. Finally, the high scores in identification with physical exercise found among the Pilates practitioners in both the initial and final assessment and the relationships between the levels of identification with exercise and adherence to physical programmes could justify its popularity.

Keywords: Pilates method, mental health, identification with physical exercise, workplace health

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Study of Interpersonal Coordination in the Marking Dynamic of Football: Effects of Task Manipulation in Different Training Categories

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Abstract

The objective of this thesis was to analyse the trends in interpersonal coordination under different marking intensities in different age categories in football. More specifically, it set out to map and describe the interpersonal coordination dynamic based on the tools of dynamic systems, in which it was possible to verify the coordination tendencies that emerged in the different contexts presented. Marking intensity was manipulated by altering the playing space and the amount of ball possession time in the small-side football game popularly known as rondo. Five participants from each age category (sub-13, sub-15, sub-17 and sub-20) played in a training environment combining four experimental conditions: expanded space and free ball possession (AL), expanded space and restricted ball possession (AR), reduced space and free ball possession (RL) and reduced space and restricted ball possession (RR). The independent variables were age category (sub-13, sub-15, sub-17 and sub-20) and marking intensity (AL, AR, RL and RR). The dependent variables were performance in play (measured by rally time, ball speed and passing frequency), pass topology (measured by interpersonal distances, angle and speed of the pass in each pass) and marking synergy (measured by the relationship between distances from the marker's ball and the barycentre). Analysis procedures and tools were developed to observe the players' interpersonal coordination trends. The results demonstrated that: 1) markers and passers are closely connected (discussed here as marking synergy); 2) marking synergy emerges from a flexible and adaptive change of passes; 3) marking synergy is bolstered according to marking intensity; and 4) marking synergy is bolstered according to age and experience in the modality. It transpires that interpersonal coordination in marking (marking synergy) can be analysed as an emerging and self-organised process within the context of action, opening up new avenues of research and intervention in group invasion sports.

Keywords: ecological dynamic, dynamic systems, marking synergy, interpersonal coordination, football

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Analysis of an Online Community of Practice of Physical Education Professionals

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Abstract

This research studies the functioning of an online community of practice of physical education (PE) professionals. In the 2013/2014 and 2014/2015 academic years, 45 participants interacted in (Re)Produce, a community belonging to the MultiScopic virtual platform, where exchanges of experiences, information, opinions and suggestions take place based on the teaching practice of several teachers in schools in four provinces in Spain, which are shared in the community via photographs, videos and textual narrations. During the study, the functioning of this community of practice was analysed, along with the PE knowledge generated by it from three different standpoints, as well as its capacity as a means of teachers' professional development, starting with pre-service training. As it is essentially a qualitative study, interviews with the participants at different levels of professional socialisation were held to collect data in the successive phases of the study; two field diaries were created by the researcher, and the texts produced by the members of the community were analysed using scatter plots and were compared with the existing theoretical corpus to establish differences and similarities. The study confirmed the difficulty of sharing knowledge and experiences due to the dispersion of dialogues, which take place in the participants' comfort zones, involving a vast variety of topics discussed, forms of dialogue and types of participation. Multiple participation barriers and motivations were identified in both pre-service teachers and those engaged in continuous training in different educational stages. This study also monitored the assimilation process via the virtual community of a new pedagogical trend by one participant and investigated the potential usefulness of this platform for teachers' professional development, although certain aspects need to be improved before it can be offered as a more effective tool for this purpose.

Keywords: physical education, virtual community of practice, teachers' professional development

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Dynamic of the Professional Training Process in Physical Culture Graduates in the Cuban Community Context

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Abstract

This study uncovers the shortcomings of Physical Culture (PC) students in solving professional problems related to didactic-professional integration, thus limiting their effective insertion into the community due to this scientific problem. The objective is to develop a didactic strategy for the professional training process of PC graduates, supported by a model of the dynamic of this process in the community setting. The model obtained yields a professional development logic for these students based on the integration-oriented systematisation of the spheres of action, the aim being to provide psychomotor and social orientation through the community practice of different types of physical activity. The didactic strategy of the professional training process of PC graduates is introduced into teaching practice and reveals the transformations in students' actions with regard to the identification of the community's sociocultural and physical activity needs, the application of different forms of diagnosis, programming, monitoring and evaluation of physical, sports and recreational activity according to conditions (diseases), ages, harmful habits, sociocultural needs; goal-setting, the selection of the content of the physical activity and the adjustment of its load for implementation, aligned with the characteristics and demands of the community setting based on the integration of the applicable laws, principles, didactic categories and spheres of action in their professional practice. A diagnosis of the PC courses was performed by applying empirical research methods and techniques such as observation, document analysis and surveys of teachers and students, and the professional training process of PC graduates as the subject of the research was defined on the basis of this analysis. Based on the foregoing, new scientific contributions are evidently needed if we are to articulate the professional training of students from the pedagogical and technical-methodological standpoint. The epistemological and praxiological grounding of the object and the field renders it possible to configure the orientation of the training of these professionals by promoting the integration of didactic-professional contents to achieve their effective insertion into the community. The practical significance of the outcomes is mirrored in the transformation of the students' action. The result of the research reveals a professional training logic that encourages the integration of the spheres of action into the community context in order to deal with professional problems that require the application of didactic-professional content.

Keywords: community context, professional problems, physical activity, sociocultural needs

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Effects on Physical Condition of an Exercise Programme in Clarinettist and Oboist Vocational Education Students through an E-learning Tool

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Section:
Doctoral Dissertations

Cover:
New Olympic Sports for Tokyo 2020: Karate. Photo: Haifa, Israel - July 11, 2017: The Karate competitions during 20th Maccabiah Games at the Romema Arena.

Abstract

The majority of studies related to the health of musicians deal with the specific epidemiology of injuries in these professionals, whereas very few studies address prevention strategies. Therefore, measures to reduce the risk of injury must be sought, with the main premise being individualisation and the characteristics of the musical instruments. A literature review found that the most common causes of injury stem from the actual instrument, lack of physical fitness (Sardá, 2003) and the demands of the repertoire (Bejjani et al., 1996; Carson, 2003), among others. This study proposes applying a specific autonomous programme of exercises targeting clarinettists and oboists designed to improve their overall physical condition and body posture by strengthening the upper extremities and spine using an e-learning tool. To verify the exercise programme, a pilot study lasting 18 sessions was conducted with 19 vocational education students in the clarinet and oboe specialities. The participants' aerobic capacity did not change significantly, but they did present changes in the strength of their trapezius and latissimus dorsi ($p=0.001$). With regard to body posture, the alignment of the head-neck vertex ($p=0.003$), the retracted chin ($p=0.025$) and the acromion aligned with the ear and the greater trochanter ($p=0.008$) were the most representative data. Similarly, these changes were reflected in instrumental performance, with the alignment of the acromion with the earlobe and the greater trochanter ($p=0.005$). After several modifications to the programme, a second study with 12 sessions ($n=29$) was conducted. The strength values were also significant for the trapezius ($p=0.003$) and the latissimus dorsi ($p=0.008$), and predictive analyses highlighted the possible variations in the strength of the latissimus dorsi after the first 6 sessions ($p=0.006$). Furthermore, the tests performed showed that the results indicated favourable changes in body posture during performance with the instrument compared to the initial assessment. The users positively rated the e-learning tool used through a questionnaire designed ad-hoc. On completion of the study, it was concluded that the exercise programme proposed via the e-learning tool facilitates a positive development of strength and favourable posture changes in the standing position reflected in instrumental performance, whereby it could constitute an effective injury prevention procedure in this group.

Keywords: music, prevention, injuries, exercise, E-learning