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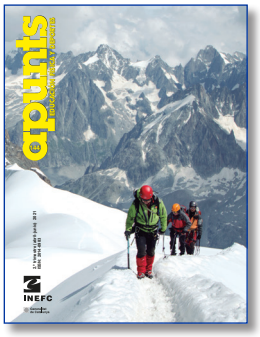

OPEN ACCESS

Relationship between Motivation, Sex, Age, Body Composition and Physical Activity in Schoolchildren

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Abstract

Doing physical activity in adolescence is regarded as one of the health protection factors that deliver numerous physical, mental and social benefits. This study set out to ascertain the relationships between the motivation to do physical activity in a group of secondary education adolescents (taking task or ego orientation into account) and the sex, age, level of physical activity, BMI and morphotype variables. It is a descriptive cross-sectional study involving 466 adolescents aged between 11 and 16 years (13.95 ± 1.46 years), of whom 53.9% ($n = 251$) were boys and 46.1% girls ($n = 215$). It was found that girls and younger students are more task-oriented in doing physical activity as are obese and overweight subjects and those who regard themselves as an ectomorph morphotype. Boys are more ego-oriented in doing physical activity. The multiple factors involved in doing physical activity in adolescence need to be studied. It would seem expedient to promote task orientation in the performance of physical activity in secondary education (especially among boys and older adolescents) both in and out of school, since this can lead adolescents to embrace a greater level of physical activity or to maintain their level in the future.

Keywords: ego, morphotype, motor activity, secondary education, task

Introduction

Physical activity (PA) is regarded as one of the most decisive factors in people's health status. Regular physical activity has a positive impact on quality of life, promotes the adoption of other healthy habits and also provides numerous physical, psychological and social benefits (Rosa-Guillamón, 2019). In adolescence, doing physical activity takes on particular relevance: on the one hand, because habits that will be maintained in adult life are established, and on the other because it acts as a protective factor against other risk behaviours to health such as obesity and being overweight or the use of harmful substances (Usán et al., 2018).

Obesity and being overweight in childhood and adolescence are regarded as one of the main public health problems of our times by the World Health Organisation (OMS, 2020). Moreover, they often generate associated health problems such as diabetes, cardiovascular problems, hypertension, low self-esteem, etc. Since PA is essential to maintaining a healthy weight, several studies have focused on ascertaining the factors that condition participation by young people in regular PA, these factors being environmental, personal or family-related (Laird et al., 2016; Yao & Rhodes, 2015).

Of the personal factors that condition the performance of PA, a person's goal orientation is important and may be of two types: task- or ego-oriented. Thus, task-oriented people conceptualise success on the basis of personal improvement and effort, whereas ego-oriented individuals are more geared towards attaining greater skill or competence than others (Guivernau, 1994). For this reason, some research into PA has targeted the analysis of motivation and the search for success in PA, focusing on the study of goal orientation. In this line, the Goal Orientation in Exercise Scale (GOES) (Killpatrick et al., 2003) has proven to be a useful tool in the study of non-competitive exercise. The research conducted by Moreno et al. (2007) validates the scale and attributes suitable validity of construct, reliability and predictive validity to it with a global score of 0.8 (Moreno et al., 2007).

The scientific literature identifies motivation as a primary factor in regular performance of PA, studying the relationships between the type of motivation to do PA and other variables such as the sex and age of the adolescents or their level of PA performance (De la Torre-Cruz et al., 2017). Moreover, some research has shown that task orientation in doing PA is directly related to a greater level of performance (Giner et al., 2020) and sustained performance in the future (Jaakkola et al., 2016).

In terms of adolescents' sex, the studies point to task orientation being greater in girls and to ego orientation being greater in boys. Task orientation is also shown to be greater the younger the age, as ego orientation increases with age in adolescents, particularly in boys (Sánchez-Alcaraz et al., 2016).

Morphotype is defined as the morphological type that characterises a specific group of organisms, a classification tool depending on the individual's physical constitution. Therefore, there are three types of morphotype: ectomorph (skinny, lean build, thin and elongated frame), mesomorph (athletic build, strong muscle development, strong frame) and endomorph (rounded and soft build, undefined muscles). In adolescence, the greatest frequency of PA, according to the studies, is recorded in the mesomorph group, whose main reasons for doing PA are enjoyment and socialisation, and who also see themselves as being more competent through the performance of physical activity and sports. Finally, ectomorph adolescents, followed by endomorphs, do weekly PA least frequently (Moral-García et al., 2014).

Despite the background, there is insufficient information to relate adolescents' goal orientations to different variables related to sex, body composition and doing PA. Therefore, the objective of this research was to analyse the connection between goal orientations, to wit ego or task, and sex, age, level of PA performance, body mass index and morphotype in secondary education students. The hypotheses were that males and more physically active students were more ego-oriented; as age increases, students are increasingly more ego-oriented; overweight or obese adolescents are more task-oriented compared to normal-weight adolescents; schoolchildren who regard themselves as endomorphs are more task- than ego-oriented.

Methodology

Participants

A descriptive cross-sectional study was performed in which random probability sampling was used to obtain the sample. A total of 466 compulsory secondary education (CSE) adolescents aged between 11 and 16 years (13.95 ± 1.46 years) participated, of whom 53.9% (n = 251) were boys and 46.1% girls (n = 215), and who were attending two schools, one rural and the other urban. Before the research began, both the schools and the students' parents or legal guardians were informed and were asked to sign an informed consent form to authorise the students' participation. The inclusion criteria were as follows: authorisation by the school, positive informed consent, having no injury or disease preventing the regular performance of PA and a positive medical report confirming optimal health status. The exclusion criteria were refusal by the student to participate or failure to fulfil one or more of the inclusion criteria. The study followed

the premises of the Declaration of Helsinki at all times as well as research ethical standards in sport sciences. The approval of the Research Ethics Committee of the Pontifical University of Salamanca was also secured.

Materials and instruments

Sociodemographic questionnaire.
The respondents (male and female) were asked to provide information about sex and age.

PA performance questionnaire.
The "MVPA" (Prochaska et al., 2001) international questionnaire, comprised of two items that collect information about the days in the week on which at least one hour of moderate-to-vigorous PA is performed, both in the previous week and in a typical week, was used to analyse the degree of PA. The response scale for both of them was the same (0=no day, 1=one day, 2=two days, 3=three days, 4=four days, 5=five days, 6=six days and 7=seven days). Both items were used in the study and the mean of both was calculated, as in previous studies (Martínez-López et al., 2018). The questionnaire's internal consistency was determined, yielding high values (Cronbach's alpha=.885). This questionnaire was used to form two initial groups: sedentary (equal to or less than 3 days of PA a week) and active (at least 4 days of PA a week).

Body Mass Index (BMI).
Body composition was studied by means of BMI (height-weight ratio). The measuring instruments used for weight and height were an Elegant model digital scale by ASIMED® (Barcelona) and a SECA® 214 portable stadiometer (Ruiz-Ariza et al., 2019). The participants were measured barefoot (wearing thin sports socks) and were weighed with light clothing, comprised of shorts and a short-sleeved T-shirt. BMI was estimated by means of the kg/m^2 ratio and the subjects were classified as low weight, normal weight and overweight.

Goal Orientation in Exercise Scale (GOES) questionnaire (Kilpatrick et al., 2003).
It is used to measure goal orientations in physical exercise. The scale is comprised of 10 items which begin with the sentence "I feel more satisfied doing exercise when…" Five of them measure task orientation (1, 2, 3, 4 and 5) (example of item 1 "I learn something while exercising and it makes me want to participate more") whereas the remaining five measure ego orientation (6, 7, 8, 9 and 10) (example of item 6 "I can do better than my friends"). The question has a Likert-type scale ranging from "strongly disagree" (1) to "strongly agree" (5). The original internal consistency of the instrument for both subscales was alpha .79 and .90 for task and ego, respectively.

Perceived morphotype.
Developed by Sheldon in 1970 by means of infographics (endomorph, mesomorph or ectomorph), it can be used to help students to choose the image they most relate to (Sheldon, 1970).

Procedure

The questionnaires were administered in normal class time and were supervised at all times by the physical education teaching staff who had been trained by the team of researchers. The participants were given brief instructions and the confidentiality of their responses was ensured. Participation was totally voluntary and the participating students received no compensation for their contribution. The questionnaire took approximately 20 minutes to complete depending on participant capability and age.

Data analysis

The normality of the variables analysed was examined by means of the Kolmogorov-Smirnov test. The sample description was conducted with frequency analysis. The differences between groups were analysed by means of a one-way ANOVA. Bivariate Pearson correlation analysis was performed. The data were processed anonymously at all times by means of a coding system and a 95% confidence interval was used for all the results. The statistical analyses were performed with the SPSS program, v. 23.0 for Windows (SPSS Inc., Chicago, USA).

Results

The general description of the sample by means of the frequency analysis determined, with regard to age, that the largest group was 13-14 years (43.9%), followed by 15-16 years (37.9%) and 11-12 years (18.2%). In terms of PA level, the active participants (51.2%) group was larger than the sedentary participants (48.8%) group. By BMI, 57.7% were of normal weight, 35.8% low weight and 6.5% overweight. Morphotype presented a distribution in which 59.2% were catalogued as mesomorphs, 21.9% as ectomorphs and 18.9% as endomorphs.

The ANOVA showed significant differences between the task- and ego-orientation subscales in the sex, age, PA level, BMI and perceived morphotype variables. Males presented a greater ego orientation than females ($p<.05$) in items 8 "I am the best" (2.52±1.32 vs. 1.96±1.10) and 9

"I am the only one who can exercise at some high intensity" (2.60 ± 1.22 vs. 2.08 ± 1.18). In terms of age, task orientation was more marked among younger students than older ones ($p < .05$), as shown by items 2 "I learn a new skill by trying hard" (4.42 ± .76 vs. 3.66 ± 1.12); 3 "Something I learn while exercising makes me want to go and participate more" (4.30 ± .76 vs. 3.69 ± 1); 4 "An exercise skill I learn really feels right" (4.32 ± .82 vs. 3.60 ± 1.14); and 5 "I am learning and having fun" (4.55 ± .73 vs. 3.86 ± 1). The level of PA performance reflected significant differences ($p < .05$) where the active schoolchildren were more motivated than the sedentary ones, both in item 1 "I learn something while exercising and it makes me want to participate more" (4.01 ± 1.09 vs. 3.71 ± .94) and item 3 "Something I learn while exercising makes me want to go and participate more" (4.18 ± .93 vs. 3.68 ± .99) of task orientation, and in item 9 "I am the only one who can exercise at some high intensity" (2.50 ± 1.28 vs. 2.22 ± 1.14) and item 5 "I am learning and having fun" (4.28 ± .94 vs. 4.02 ± .98) of ego orientation. Although BMI presented fewer significant differences, item 3 "Something I learn while exercising makes me want to go and participate more" ($p < .05$) showed that low-weight adolescents (3.98 ± 1.06) were more task-oriented than normal-weight (3.95 ± .95) and overweight (3.93 ± .96) participants. Perceived morphotype showed that ectomorphs were the least motivated, both in task-related items and in item 1 "I learn something while exercising and it makes me want to participate more", and ego, with item 9 "I am the only one who can exercise at some high intensity", yielding significant differences in both items between the three groups (3.70 ± 1.12 vs. 3.85 ± .99 vs. 4.17 ± 1.06 y 2.08 ± 1.08 vs. 2.40 ± 1.19 vs. 2.44 ± 1.40, respectively). The remaining results for the other variables are also presented in Table 1.

An analysis of associations was also performed, yielding a positive correlation between the ego and task factors ($p < .01$; PC: .542). The negative correlation between the respondents' sex and the ego ($p < .01$; PC: -.297) and task ($p < .01$; PC: -.229) subscales shows that males tended to present greater orientation in both cases than females. Age is negatively correlated ($p < .01$; PC: -.287) to task, suggesting that task orientation diminishes as age increases. PA level was positively correlated to task ($p < .01$; PC: .243) and negatively to the adolescents' sex ($p < .01$; PC:-.246) and age ($p < .01$; PC: -.184), showing that the physically more active participants are more task-oriented and also that PA level is higher in males and younger schoolchildren. BMI was positively correlated to age ($p < .01$; PC: .244) showing that BMI rises as age increases. Finally, morphotype was positively correlated to task ($p < .05$; PC: .155) and negatively to BMI ($p < .01$; PC: -.334), thus confirming that endomorph participants are the least task-oriented and also that there is a clear relationship between endomorphs and overweight individuals (Table 2).

Discussion

Numerous studies have sought to identify the conditioning factors associated with the performance of PA in adolescence, the most frequent being related to satisfaction, motivation, body image, BMI, the performance of exercise by people from their own environment (family and peers), etc.

The primary objective of this paper was to study the possible correlations between the performance of PA by adolescents and their motivation to do so (task or ego orientation), as well as other variables that may condition the performance and/or maintenance of physical activity, such as sex, age, BMI and perceived morphotype.

Correlations were found in all the variables studied, the first discovery being that the motivation to do PA (task or ego orientation) was correlated to all the variables studied. By sex, boys presented greater ego orientation than girls, while there is greater ego orientation in the performance of PA as age increases. Active adolescents are more motivated by PA and adolescents with a lower BMI are more task-oriented in doing it. By morphotype, ectomorph subjects (skinny, lean build, thin and long frame) are the least motivated (in both task and ego orientation).

The first hypothesis was that males and more physically active students were more ego-oriented, which was fulfilled in terms of goal orientation depending on the respondents' sex. As in other studies (Castro et al., 2019; Carriedo et al., 2015; Sánchez-Alcaraz et al., 2016), boys presented greater ego orientation in the performance of PA. In recent years, the role of gender in doing physical and sports activities has been studied (Alvariñas-Villaverde & Pazos-González, 2018; Calvo-Ortega & Perrino-Peña, 2017) and it has been found that girls evince greater interest in less sports-related activities, whereas boys tend to be more inclined towards competition (Alvariñas-Villaverde & González-Valeiro, 2020).

Since the second hypothesis posited that older students were more ego-oriented, this hypothesis may also be regarded as having been met. On the basis of these results, it would seem expedient to promote greater task-focused motivation in a more specific fashion among secondary education students as this type of motivation improves the performance of PA, commitment and enjoyment and therefore the maintenance of this activity (García et al., 2019). It also helps young people who do sport to be more consistent or persevering and to make an effort when faced with complex tasks (Gutiérrez et al., 2017).

Table 1
Analysis of variance of the GOES questionnaire by sex, age, level of PA, BMI and morphotype.

SUBSCALE			TASK	TASK	TASK	TASK	TASK	EGO	EGO	EGO	EGO	EGO	
QUESTIONNAIRE ITEMS (from 1 to 10).			(1) I learn something while exercising and it makes me want to participate more	(2) I learn a new skill by trying hard	(3) Something I learn while exercising makes me want to go and participate more	(4) An exercise skill I learn really feels right	(5) I am learning and having fun	(6) I can do better than my friends	(7) Others do not perform as well as me	(8) I am the best	(9) I am the only one who can exercise at some high intensity	(10) Others cannot do as well as me	*P* (sig.)
SEX	Male	M	3.97	4.13	4.13	4.08	4.16	3.41	3.13	2.52	2.60	2.79	(3) p = .014 (8) p = .01 (9) p = .005
		SD	1.07	1.00	.92	1.03	1.02	1.12	1.26	1.32	1.22	1.32	
	Female	M	3.80	3.84	3.73	3.70	4.17	3.04	3.13	1.96	2.08	2.09	
		SD	.98	1.04	1.04	1.15	.94	1.12	1.17	1.10	1.18	1.10	
AGE	11-12 years	M	4.32	4.42	4.30	4.32	4.55	3.67	2.75	2.06	2.28	2.42	(2) p = .001 (3) p = .013 (4) p = .07 (5) p = .01
		SD	.77	.76	.76	.82	.73	1.06	1.18	1.06	1.29	1.24	
	13-14 years	M	3.99	4.11	4.02	4.00	4.27	3.20	2.91	2.34	2.46	2.53	
		SD	1.11	.96	1.03	1.10	.99	1.20	1.29	1.34	1.24	1.27	
	15-16 years	M	3.57	3.66	3.69	3.60	3.86	3.08	2.71	2.27	2.29	2.42	
		SD	.97	1.12	1.00	1.14	1.00	1.04	1.29	1.26	1.18	1.29	
PA LEVEL	Sedentary	M	3.71	3.82	3.68	3.61	4.03	3.13	2.70	2.17	2.22	2.35	(1) p = .015 (3) p = .001 (9) p = .012 (5) p = .021
		SD	.94	.97	.99	1.14	.98	1.09	1.24	1.23	1.14	1.20	
	Active	M	4.01	4.14	4.18	4.18	4.28	3.36	2.84	2.33	2.50	2.60	
		SD	1.09	1.06	.93	.99	.94	1.13	1.28	1.28	1.28	1.30	

Note: in the *p* (sig) column, the number in brackets "()" corresponds to a questionnaire item (numbered from 1 to 10).

Table 1 *(Continuation)*
Analysis of variance of the GOES questionnaire by sex, age, level of PA, BMI and morphotype.

SUBSCALE			TASK	TASK	TASK	TASK	TASK	EGO	EGO	EGO	EGO	EGO	
QUESTIONNAIRE ITEMS (from 1 to 10).			(1) I learn something while exercising and it makes me want to participate more	(2) I learn a new skill by trying hard	(3) Something I learn while exercising makes me want to go and participate more	(4) An exercise skill I learn really feels right	(5) I am learning and having fun	(6) I can do better than my friends	(7) Others do not perform as well as me	(8) I am the best	(9) I am the only one who can exercise at some high intensity	(10) Others cannot do as well as me	*P* (sig.)
BMI	Low weight	M	3.98	4.09	3.98	4.06	4.27	3.40	2.86	2.19	2.29	2.56	(3) p =.028
		SD	1.14	1.01	1.06	1.09	1.01	1.23	1.28	1.20	1.22	1.26	
	Normal weight	M	3.82	3.97	3.95	3.88	4.12	3.22	2.84	2.37	2.45	2.49	
		SD	1.01	1.04	.95	1.09	.98	1.05	1.22	1.28	1.22	1.28	
	Overweight	M	3.53	3.86	3.93	3.66	4.13	3.40	3.00	2.00	2.53	2.40	
		SD	.91	1.06	.96	.81	.91	.82	1.41	1.46	1.30	1.35	
MORPHOTYPE	Endomorph	M	3.70	3.96	3.72	3.60	4.06	2.96	2.60	2.00	2.08	2.24	
		SD	1.12	.96	1.14	1.17	1.05	1.06	1.21	1.10	1.08	1.15	
	Mesomorph	M	3.85	3.98	3.95	3.95	4.13	3.27	2.85	2.29	2.40	2.58	(1) p = .027 (9) p = .035
		SD	.99	1.04	.93	1.07	.97	1.05	1.20	1.23	1.19	1.27	
	Ectomorph	M	4.17	4.13	4.14	4.06	4.37	3.43	2.82	2.37	2.44	2.37	
		SD	1.06	.99	1.02	1.09	.95	1.35	1.46	1.43	1.40	1.37	

Note: in the *p* (sig) column, the number in brackets "()" corresponds to a questionnaire item (numbered from 1 to 10).

Table 2
Associations between the ego, task, sex, age, PA level, BMI and morphotype variables.

		Ego	Task	Sex	Age	PA level	BMI	Morphotype
Ego	r	1	.542**	-.297**	-.035	.119	-.011	.098
	Sig.		.000	.000	.570	.052	.864	.114
Task	r		1	-.229**	-.287**	.243**	-.045	.155*
	Sig.			.000	.000	.000	.486	.012
Sex	r			1	-.005	-.246**	-.123	-.007
	Sig.				.933	.000	.055	.905
Age	r				1	-.184**	.244**	-.083
	Sig.					.002	.000	.178
PA level	r					1	-.021	.008
	Sig.						.744	.891
BMI	r						1	-.334**
								.000
Morphotype	r							1

**The correlation is significant at the level of .01 (bilateral).
**The correlation is significant at the level of .05 (bilateral).
r: Pearson's correlation; Sig.: Bilateral significance.
Ego and task: scores from 1 to 5 (1 = strongly disagree to 5 = strongly agree).
Sex: 1 (male) and 2 (female)
Age: 1 (11-12 years), 2 (13-14 years) and 3 (15-16 years).
PA level: 1 (sedentary) and 2 (active).
BMI: 1 (low weight), 2 (normal weight) and 3 (overweight).
Morphotype: 1 (endomorph), 2 (mesomorph) and 3 (ectomorph).

The third hypothesis, which suggested that obese or overweight adolescents were more task-oriented than normal-weight adolescents, is met, concurring with the study by Ahmed (Ahmed et al., 2017), although the result may be due among other things to the fact that they are less concerned with physical appearance.

The fourth hypothesis, which posited a positive relationship between regarding oneself as endomorph and being more task-oriented, is not met since the analysis of associations shows that endomorph participants are the least task-oriented whereas ectomorphs are the most task-oriented participants. In view of the scant research that takes these two variables (BMI and morphotype) into account in goal-orientation studies, it could be worthwhile to consider both aspects when strategies that favour intrinsic motivation in doing PA are addressed.

In any case, the scientific literature shows that motivation is a key factor in the performance of physical activity and that task orientation is a core aspect to be promoted in the development of in-school and out-of-school activities since it delivers numerous benefits: better academic performance (Castro et al., 2019), greater motivation, better habits, etc.

Conclusions

Scientific evidence demonstrates the multiple benefits of doing PA in childhood and in adolescence, including the maintenance of good health and suitable weight, short- and long-term disease prevention, improved academic performance, the adoption of other healthy lifestyle habits, etc.

Studying the possible variables that condition doing PA is therefore relevant on account of its potential impact on improving people's quality of life.

The findings of this research point to the need to consider certain variables in studies on PA habits among adolescents: goal orientations (ego and task), sex and age, BMI and morphotype have proven to be relevant in this respect. Thus, in the sample studied, boys were more ego-oriented in the performance of PA, and this orientation also increases with age. Adolescents with a higher BMI (overweight and obesity) are more task-oriented. Contrary to the hypothesis, endomorph subjects are not the most task-oriented as it was the ectomorph subjects who exhibited this type of motivation in doing PA.

Based on these and other similar results, it is apposite to advocate measures, both inside and outside school, to promote task orientation in PA for adolescents. For example, other authors examined the motivational processes that unfold in physical education classes and proposed strategies to accomplish a motivational climate that increases task engagement (García et al., 2005).

Strong points, limitations and future outlook

Goal orientations were studied and related to ones that provide very valuable information, using validated instruments that have already been extensively employed with this population group.

One of the limitations of this study is that it is cross-sectional and so relationships of causality could be established.

Future research should consider other decisive psychosocial variables in the performance of PA by adolescents, as well as the design of an experimental study that would be conducive to extracting relationships of causality between the variables analysed.

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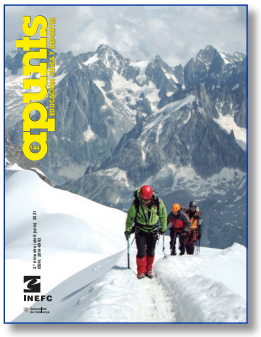

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Effect of Functional Strength Training on People with Spinal Cord Injury

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Abstract

The purpose of this study was to analyse the effects of functional training on muscle strength, functional capacity and quality of life (QoL) indicators in people with spinal cord injury (SCI). The sample consisted of five adult individuals of both sexes with SCI who did 12 weeks of functional training twice a week. Anaerobic power (ANP), movement agility, muscle strength and QoL were analysed before and after the training using the Wingate, zigzag, hand dynamometer and medicine ball throw tests and the WHOQOL-Bref questionnaire. The results showed an improvement in peak ANP ($p = .043$), relative peak ANP ($p = .043$), average ANP ($p = .042$) and relative average ANP ($p = .043$), as well as in peak agility ($p = .043$) and overall QoL ($p = .043$). It may be concluded that 12 weeks of functional training was sufficient to bring about improvements in ANP and agility with direct effects on enhanced functional capacity in people with SCI. The training programme implemented also helped to improve overall QoL.

Keywords: health, exercise, spinal cord, functional physical performance, quality of life.

Introduction

Spinal cord injury (SCI) is primarily caused by external trauma which may unexpectedly alter the injured person's life, leading to a certain degree of impairment in motor, occupational, recreational and social activities. This impairment is a causal factor and also results in reduced functioning and quality of life (QoL) (Rivers, 2018).

Conversely, physical exercise is one of the main drivers in rehabilitation and in promoting changes in the health of the public at large and also of people with SCI (Mendoza Laíz et al., 2001). As a factor for rehabilitation and health promotion, functional training seeks to enhance functioning and includes exercises drawing from natural movement rather than focusing on isolated muscle adaptations (the traditional approach) (Matos et al., 2017). This improvement observed in functional training is due to the fact that all natural movements occur in multiple joints through various planes of movement (Liu et al., 2014).

Functional training programmes are designed to simulate tasks or activities of daily living (ADLs) in order to make training adaptations more effective, for example to enable a person with SCI to perform transfers from the wheelchair to other locations without assistance. This type of training targets the neuromuscular system to stabilise the body through dynamic and isometric muscle actions in response to stressors such as gravity, ground reaction forces and momentum. Under the principle of specificity, training which replicates ADLs may be more effective in improving functional capacity (Liu et al., 2014).

Furthermore, greater functioning in people with SCI may be associated with increased ANP, as this will enhance agility (Gorgatti & Böhme, 2002), together with potential improvements in functional behaviour. According to The International Classification of Functioning, Disability and Health (ICF), functioning is determined by the health conditions and functions which an individual may perform in social participation and by the environmental setting in which they live (Farias & Buchalla, 2005). In turn, greater functioning may directly impact QoL (van Koppenhagen et al., 2014), as the domains that comprise QoL are directly correlated with functioning.

Functional training is therefore an option for promoting health, functional capacity and QoL for people with SCI. However, studies featuring functional training interventions in people with SCI are rare and are limited to rehabilitation studies and animal models (Fouad & Tetzlaff, 2012; Miranda et al., 2012). Additionally, studies evaluating the effect of functional training on ANP, agility, functional capacity and QoL in people with SCI might help to understand the potential effects of functional training on the organisation and restructuring processes of the body movements involved in ADLs, together with the potential use of functional training as a rehabilitation and health promotion strategy for people with SCI.

Consequently, the purpose of this study was to analyse the effects of functional training on muscle strength, functional capacity and QoL indicators in people with SCI.

Methodology

All the study procedures were conducted at the Strength Laboratory in the Physical Education Department of the Federal University of Viçosa, Brazil.

The study sample consisted of five people of both sexes with an SCI level between T4 and T11 and an average injury time of 18.6 years (Table 2). None of the five individuals had motor limitations in their upper limbs preventing them from performing ADLs.

The exclusion criteria were: a) having musculoskeletal or cardiometabolic problems limiting or contraindicating exercise; b) participating in other regular exercise programmes, and c) participating in less than 80% of the training sessions. Inclusion criteria were: thoracic SCI; traumatic SCI; being paraplegic; being clinically fit to participate in the study as determined by medical examination; having no upper limb paraparesis; having no previous strength training experience; and having no cognitive impairments which would preclude performance of the tests.

All the patients evaluated took part voluntarily, signed the informed consent form and received information about the study as specified in Decision 466/2012 of the National Health Council. The study was approved by the ethics committee for research involving human subjects of the Federal University of Viçosa, Minas Gerais, Brazil, under license number CAAE 51624715.2.0000.5153.

Training protocol

The intervention in this study was conducted following the guidelines for exercise prescription for people with SCI (Evans et al., 2015).

All the participants used their own means of transport (car) to get to the study site.

Before the intensity of the physical training was set, all the participants were assessed for agility, ANP and quality of life and they were asked about difficulties in performing ADLs. After this assessment, the participants tried out the strength training protocol so that the researchers could adapt the exercises to ensure that everyone was able to perform the same ones.

The participants did 12 weeks of functional training covering physical and motor skills: endurance, strength,

Table 1.
Training periodisation.

Week	1	2	3	4	5	6	7	8	9	10	11	12
Sets	2	2	2	2	3	3	3	3	3	3	3	3
Repetitions	8	8	10	10	8	8	10	10	10	12	12	12
RPE	5	7	6	7	6	7	6	7	7	6	7	7

speed, agility, balance, flexibility and coordination. The interventions were carried out twice a week and lasted approximately 60 minutes, in the course of which the participants performed eight exercises for the functional muscle groups with three sets of 10-12 repetitions per exercise.

Each session began with the participants covering 800 m in their wheelchairs as a warm-up. They then performed active stretching in the upper limbs and passive stretching in the lower region (this same routine was resumed at the end of each session). Afterwards, they did two exercises for approximately five minutes to stabilise their core (integrated unit consisting of 29 pairs of muscles which support the lumbo-pelvic-hip complex): holding an exercise ball with the hands and the elbows bent at 90° close to the trunk on which the trainer exerted a counterforce in order to unbalance the participant on the exercise ball, and barbell holding with arms at 90° to the trunk where the participants had to hold a barbell horizontally (parallel to the floor) with arms bent at 90°, with the barbell weighted at each end. Approximately 25 minutes of functional endurance exercises were performed after the stabilisation training. At the end of the session, the participants did another 800 m in their wheelchairs to make a total of 1,600 m for the session.

All the training was conducted involving the movements required for ADLs and was easy for the participants to perform and reproduce. The training was also designed so that all the exercises could be done in their wheelchairs.

The periodisation planning schedule was as follows: two sets of eight repetitions in the first week, increasing to two sets of 10 repetitions in the second week and three sets of 12 repetitions in the following weeks, with 60-second intervals between sets in the first two weeks, decreasing to 30 seconds in the following weeks (Table 1). All the participants performed the same exercises.

The training also consisted of four different exercises: chest press with elastic bands on a backrest on the participants' backs, the intensity increasing according to their perception; elbow extension with the shoulder extended to 180° and the elastic band secured to the wheelchair; shoulder horizontal abduction with elastic bands, and finally biceps curl with dumbbells.

The participants' load was monitored by Rating of Perceived Exertion (RPE) using the OMNI-RES scale (Robertson et al., 2003) with an intensity between 5 and 7. Participants were familiarised with the RPE scale in the pre-intervention period.

Although some studies show better results in acute and/or chronic high-intensity activities (Frotzler et al., 2008; Harness et al., 2008), low-to-moderate intensity loading was chosen due to the sedentary lifestyle and limited motor experience of the people with SCI included in the study.

The effects of this functional training protocol on the muscle strength, functional capacity and QoL of people with SCI were assessed by testing for anthropometry, hand grip strength, medicine ball throwing, ANP and agility, together with QoL perception before and after the 12 weeks of the intervention.

Anthropometry

Body mass was measured using a digital scale (Plenna, São Paulo, Brazil) with a capacity of 150 kg and an accuracy of 100 g. The limitation of the scale's length meant that the researcher's body mass had to be measured first, after which they stepped back on the scale holding the participant in their arms and the researcher's body mass was then subtracted from the total mass to calculate the participant's body mass.

Muscle strength

Hand grip strength was used as an indicator of peak dynamic strength and was assessed using a Jamar® hydraulic hand dynamometer (Sammons Preston Inc., Bolingbrook, IL, USA). The standard position proposed by the American Society of Manual Therapists entails testing with the individual seated in a straight-backed chair without armrests, with the elbow bent at 90° and the forearm in a neutral position. Three measurements were taken at one-minute intervals to avoid muscle fatigue and the highest value obtained in the assessments was used as the test result.

Upper limb muscle power was assessed using the medicine ball throwing test (Gorgatti & Böhme, 2002). A tape

measure and a 2-kg medicine ball were used to perform this test. The tape measure was fixed to the floor perpendicular to the wheelchair with the starting point of the tape measure located at the projection of the back of the chair on the floor. The participant was seated in their own chair with their back against its backrest and with a strap to keep them attached to the back of the chair. The medicine ball was held close to the sternum with the elbows bent. On the evaluator's signal, the participant threw the ball as far as possible without lifting their back off the back of the chair. The throwing distance was recorded from the zero area to the point where the ball first touched the ground. Two throws were performed and the better result was recorded.

Anaerobic power (ANP)

ANP was assessed by the Wingate test (Franchini, 2002) using an Excite® Top upper body ergometer (Technogym, Cesena, Italy). The test lasted 30 seconds, during which the participant rotated the handles as much as possible against a fixed resistance set according to their body mass to generate as much power as possible in this period of time. The power generated during the 30 seconds was termed average anaerobic power (AVANP) and reflected localised upper limb endurance. The highest power generated, from 3 to 5 seconds, was termed peak anaerobic power (PANP) and provided information on the maximum mechanical power output of the participants' upper limbs. To minimise the possible effects of body mass on the test results, the PANP and AVANP values were relativised by body mass to calculate relative PANP (RPANP) and relative AVANP (RAVANP). The test also provided the fatigue index representing the decrease in performance of the evaluee during the test (Franchini, 2002).

Functional capacity

The functional agility test was used as an indicator of functional capacity in the participants in this study. Wheelchair agility was assessed using the adapted zigzag test (Texas Fitness Test) (Gorgatti & Böhme, 2003). The aim of the test was to cover the total distance of a 6 x 9 m rectangle, requiring changes of direction, as quickly and efficiently as possible. Each test subject used their own wheelchair to perform the test, which was marked out with five cones. On the evaluator's signal, the participant wheeled their chair around the course as quickly as possible. Five attempts were made five minutes apart. The first was for route reconnaissance, performed at low speed, while the second was for reconnaissance at high speed. The next three were considered valid for the test. A stopwatch accurate to hundredths of a second was used and the shortest time of the three attempts was recorded as the final result.

Quality of life

The instrument used to measure QoL was the Brazilian version (Fleck et al., 2000) of the World Health Organisation Quality of Life-Bref (WHOQOL-Bref) questionnaire featuring 26 questions across six domains: physical, psychological, social relationships, environment, spirituality/religion/personal beliefs and level of independence. The domains are represented by facets and their Likert-type responses range in levels of intensity (not at all-an extreme amount), capacity (not at all-completely), frequency (never-always) and evaluation (very dissatisfied; very satisfied; very poor; very good). In the responses, 1 stands for negativity and 5 for positivity and low evaluation percentiles mean low levels of QoL.

Statistical analysis

All the data were stored and processed using the statistical software IBM SPSS Statistics 23 and AI-Therapy Statistics BETA. The descriptive analysis was performed using the mean and standard deviation. Normality of data was determined using the Shapiro-Wilk test. The results before and after training were compared using the Fisher-Pitman non-parametric permutation test. Standardised measure of effect size was calculated by Pearson's r and was classified as small (<.30), medium (.30–.50) and large (>.50) (Cohen, 1988). All the statistical analyses were performed at a statistical significance level of $p < .05$

Results

Table 2 shows the profile of the research participants. The sample consisted of participants with chronic SCI, 60% women and 40% men, and with ages between 52 and 61 years in the case of women and 24 and 34 years for men. The lesions of all study participants are in the thoracic region. The causes are diverse and the average time injury was 18.6 years.

Table 3 shows the results for the assessment of muscle strength subdivided into ANP, muscle power and hand grip strength, and functioning as measured by the agility test. Functional training was seen to increase ANP. Furthermore, the functioning of the participants who took part in the functional training was higher after 12 weeks of training, as evidenced by the quicker times in the agility test.

Table 4 shows the results of the QoL assessment using the WHOQOL-Bref questionnaire. Functional training helped to improve the participants' overall QoL. Although no significant differences were observed between the domains, the physical domain was found to have an effect size considered large and the social relationship domain had an effect size classified as medium.

Discussion

The purpose of the study was to analyse the effects of functional training on muscle strength, functional capacity and QoL indicators in people with SCI. The main results were: 1) improvement of PANP, AVANP and RAVANP to body mass in the upper limbs of people with SCI; 2) increase in functional capacity; 3) improvement in overall QoL mainly by improving the physical domains.

The functional training was effective in increasing the PANP, AVANP, PRPANP and RAVANP of the upper limbs in people with SCI. Few intervention studies have evaluated the impact of exercise on ANP in people with SCI. In the study by Jacobs (2009) which compared two groups of people with paraplegia, one performing manual cycloergometer training and the other strength training and both for 12 weeks, an improvement in upper limb ANP was found in both exercise groups.

In the study by Nash et al. (2007), an increase in muscle strength and ANP was observed in people with thoracic SCI who did circuit strength training for 16 weeks, leading to a reduction in pain and increased shoulder functioning.

The data from this study are consistent with the results of the studies described above, suggesting that strength training can impact muscle quality and lead to greater physical functioning as a result of increased ANP.

Table 2.
Characterisation of the sample.

Individual	Sex	Age (years)	Injury time (years)	Cause of injury	Injury level
1	M	34	14	Motor vehicle accident	T5
2	F	61	51	Landslide	T11
3	M	24	3	Weapon accident	T9
4	F	52	18	Weapon accident	T4
5	F	55	7	Household accident	T6

Note. F: female. M: male. T: thoracic vertebrae.

Table 3.
Value comparisons.

	Pre		Post		*p*	ES
	Average	SD	Average	SD		
Body mass (kg)	56.85	8.11	56.49	8.84	.345	.29
MP (m)	3.29	1.02	3.43	1.03	.345	.29
HGS (kg)	40.90	14.42	43.10	14.99	.144	.46
PANP (watts)	133.40	51.58	147.20	48.64	.043	.64
RPANP (watts/kg)	2.29	0.63	2.56	0.55	.043	.64
AVANP (watts)	108.80	53.27	122.00	50.23	.042	.64
RAVANP (watts/kg)	1.86	0.72	2.13	0.67	.043	.64
Fatigue index (%)	28.80	15.41	30.40	14.99	.786	.08
Agility (s)	37.02	8.33	33.54	6.20	.043	.64

Note: SD: standard deviation; ES: effect size; MP: upper limb muscle power; HGS: hand grip strength; PANP: peak anaerobic power; RPANP: relative peak anaerobic power; AVANP: average anaerobic power; RAVANP: relative average anaerobic power.

Table 4.
Comparison of quality of life values of the people with spinal cord injury before and after the 12 weeks of functional training.

	Pre		Post		*p*	ES
	Average	SD	Average	SD		
Physical domain	3.14	0.26	3.43	0.21	.08	.55
Psychological domain	3.54	0.44	3.63	0.37	.416	.25
Social relationships domain	3.19	1.42	4.13	0.69	.109	.50
Environment domain	3.02	0.50	3.21	0.46	.285	.33
Perceived quality of life	3.80	0.44	4.00	0.00	.317	.31
Health satisfaction	4.40	0.54	4.20	0.44	.317	.31
Overall quality of life	3.22	0.40	3.60	0.17	.043	.64

Note: SD: standard deviation; ES: effect size.

The reduction in ANP may be related to the degeneration of type II muscle fibres and loss of phasic motor units (Kern et al., 2008). This decrease in muscle mass in people with SCI may lead to a reduction in the individual's functioning (Sezer, 2015). However, functional training would appear to promote anaerobic neuromuscular adaptations which bring about an improvement in ANP. It is consequently a strategy to be considered to reverse ANP losses and potentially enhance the functional capacity of people with SCI.

The functional training improved the agility of the participants in the intervention as measured by the adapted zigzag wheelchair agility test. Similarly, the study by Ozmen et al. (2014) showed that a 6-week explosive strength training programme at 50% of 1RM was effective in increasing speed and agility in wheelchair basketball players when added to their training routine. This appears to be the only functional training intervention in the literature to have assessed agility in people with SCI. There are agility measurements in wheelchair basketball (Fréz et al., 2015) and wheelchair handball (Silveira et al., 2012) players, but as they did not include any intervention it is difficult to compare them with the results found here.

Improved agility is associated with enhanced ANP (Ozmen et al., 2014). Agility, measured as the ability to make rapid changes of direction, is an important variable for the functioning of the person with SCI. The greater the agility, the more freely and safely the person can get about in their wheelchair. Conversely, impaired agility leads to a limited physical mobility which will make it impossible for the person with SCI to move autonomously and freely (Fechio et al., 2009).

Another plausible explanation for the improvement in agility might be associated with the ecological validity of this study, since in addition to all the assessments taking place in the participants' own wheelchairs, the functional training also stimulated the use of movements which simulated ADLs. Once again, functional training has proven to be an effective strategy in improving agility, thus confirming its relevance as a potential component in rehabilitation and health promotion for people with SCI.

The functional training may have been the starting point for the improvement in the overall QoL of the people with SCI who participated in this study and might be related to the physical and social relationship domains. Although no significant difference was observed in the physical domain ($p = .08$), there was a large effect size (ES = 0.55), suggesting that the intervention had an effect on this domain and also on the results seen in ANP and agility. Similarly, while no significant difference was observed in the social relationship domain between the assessment times ($p = .109$), a medium effect size (ES = 0.5) was found, an outcome which may be explained by the benefits of regular exercise for symptoms such as depression and anxiety, as well as distraction, self-efficacy and social interaction (Peluso & Andrade, 2005).

Hicks et al. (2003) found a positive correlation between muscle strength, ANP, agility and QoL in a study which examined the effect of nine months of twice-weekly strength training with an average duration of 90-120 minutes and at an intensity of 70-80% of 1RM on muscle strength, psychological wellbeing indices and QoL in people with SCI. Their results showed increased muscle strength and improved psychological indices with lower levels of stress and depressive symptoms, greater satisfaction with their

physical functioning, less pain and improved self-concept. The authors therefore suggest that people with SCI can significantly improve their sense of wellbeing by taking part in a structured exercise programme and that exercise can be used as a therapeutic approach to augment physical fitness and physical and mental wellbeing.

Similarly, Mulroy et al. (2011) evaluated the effect of a 12-week, three times a week strength training programme with an average of 11 repetitions using low-intensity body-weight exercise on the relationship of shoulder pain and movement in individuals with SCI. The results showed a two-thirds reduction in baseline shoulder pain levels that allowed the people to successfully perform social activities and ADLs, with a subsequent improvement in QoL and physical and social functions.

Consequently, functional training would seem to be a therapeutic approach likely to enhance functioning by increasing strength and ANP and also reducing psychological and physical impairment, while also improving social life, reflected in better QoL of people with SCI (Val-Serrano & García-Gómez, 2020). Practitioners involved in prescribing exercise for people with SCI are therefore recommended to consider prescribing functional training when the purpose of the exercise programme is to augment strength, functional capacity and QoL. Finally, the functional training used in this research is a strategy which can be implemented relatively straightforwardly as all the exercises performed are easy to reproduce and do not call for specialised equipment, which also attests to its practical usefulness in exercise prescription for people with SCI.

Notwithstanding the positive results found in this study, certain limitations (or specificities) were observed which should be considered when analysing the results. The sample size was small, meaning that the results cannot be generalised to individuals with different levels and degrees of SCI impairment. However, the research pursued ecological validity by not altering the regional and social circumstances of the participants and by including activities compatible with their daily routines. The limitations of the absence of a control group and not controlling for the participants' level of physical activity should also be considered. Nevertheless, all of them initially stated in an interview that they did not engage in regular physical exercise.

Conclusion

The results of this study led to the conclusion that 12 weeks of functional training was sufficient to yield improvements in ANP and agility with resulting direct effects on enhanced functional capacity in five people of both sexes with traumatic SCI between T4 and T11 and without paraparesis or other motor limitations in their upper limbs. Furthermore, the training programme implemented helped to improve overall QoL and enhance the participants' physical and social relationships domains. These results suggest that functional training is a strategy that should be considered, as it increases the functional capacity and QoL of people with SCI with similar motor and health conditions to the sample studied in this paper.

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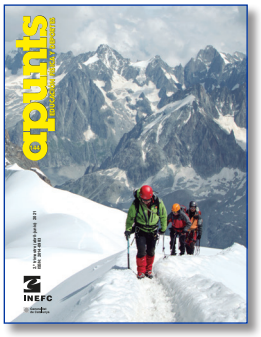

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Health Profile, Cardiovascular Risk Prevention and Physical Exercise in Adolescents

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Abstract

The objective of this paper was to ascertain health profile and cardiovascular risk prevention by means of the personal and family background and an electrocardiogram of adolescents in order to improve the indications for doing physical exercise in schools. A descriptive, observational study was performed with a cohort of pupils from state and private schools. *Sample:* 1391 adolescents (667 boys and 724 girls). *Methodology:* descriptive, observational study. Structured questionnaire about the family and personal background of physical exercise and risk factors and the performance of an electrocardiogram. *Results*. Physical exercise of between two and five hours a week was performed by 45% of the boys and 47% of the girls and for more than five hours by 39.7% and 23%, respectively. *Symptoms:* isolated palpitations (23.7% boys and 39.1% girls), dizziness and/or transient loss of consciousness without consequences (7.3% and 13.8%, respectively), some type of controlled cardiac pathology (4.2% boys and 2.1% girls). In the electrocardiograms, 59 presented unspecific repolarisation alterations and nine an incomplete right bundle branch block, with heart disease being ruled out in all of them. *Risk factors detected:* arterial hypertension (2.3%), hypercholesterolaemia (7.3%), diabetes (2.3%), pre-obese (7.6% boys and 6.5% girls), obesity (2.2% and 1.5%, respectively) and smokers of more than six cigarettes a day (1.2% boys and 2.2% girls). *Conclusion.* The information from the pupils about their personal and family background and cardiovascular history, the electrocardiogram and their level of physical activity makes it possible to carry out a health education programme that will help to improve eating habits, perform physical activity and eliminate bad and unhealthy habits.

Keywords: adolescence, cardiovascular risk, electrocardiogram, physical exercise, primary prevention

Introduction

Young people who live in cities or in rural communities have gradually shifted towards a sedentary lifestyle, mainly due to greater travel facilities and the advent of new technologies and games that reinforce a largely physically inactive life. This is one of the arguments that have been used to promote out-of-school sport, since the hours spent on physical exercise in the educational syllabus are regarded as insufficient. The lack of physical exercise combined with unsuitable eating habits are relevant factors that impact the health of adolescents and adults alike.

The promotion of sports and physical activity (PA) in schools is geared towards improving health through changes in lifestyle, ensuring it is performed in suitable conditions and drawing on the pupils' basic health information. The modification of eating habits and health education with a view to avoiding overweight, smoking and drinking alcohol are other aspects that should be addressed in order to be the starting point for their future lifestyle model as adults and outside the school setting (Villalbí et al., 2012; Lobos & Brotons, 2011; Rendo-Urteaga et al., 2015).

One solid argument for doing sports and avoiding unjustified exclusions from them is having access to information about pupils with any kind of cardiovascular problem. Nevertheless, what matters most is the possibility of designing programmes tailored to individual conditions in order to improve physical qualities and enhance risk prevention.

A decrease in hours of sedentary lifestyle and an increase in moderate-to-intense PA is associated with a reduction in cardiovascular risk factors and metabolic alterations, loss of fat mass percentage, increased insulin sensitivity, reduction in plasma lipids and better physical exercise tolerance (Ekelund et al., 2012; Väistö et al., 2018). Similarly, schoolchildren's cognitive function is known to increase if they are physically active at break times, which is another way of reducing sedentary time (Rendo-Urteaga et al., 2015).

The coexistence of several risk factors begins at an early age and is associated with the onset of arteriosclerosis. These factors are more evident in older adolescents. Obesity associated with cardiometabolic syndrome induces diabetes, hypertension and silent cardiovascular disease (Tanrikulu et al., 2016; Newman et al., 1986; Berenson, 2009). It is crucial that these factors, all of which can be modified, are targeted by early prevention actions through changing diet, doing physical exercise and conducting health education programmes, particularly in the more socially underprivileged groups (Bibiloni et al., 2012; Ortega et al., 2018).

Adolescents begin to drink alcohol and smoke in this stage. Nevertheless, this tendency is tapering off, largely thanks to prevention campaigns and the laws enacted (Villalbí et al., 2012; Sánchez-Quejia et al., 2015), albeit recent data point to a fresh rise in consumption and changes in their habits. Alcohol and smoking are related to many diseases, especially ones involving cardiovascular risk factors and diseases, and hence preventing drinking alcohol and smoking at early ages is of paramount importance.

Objective. To ascertain health profile and cardiovascular risk prevention by means of the personal and family background and an electrocardiogram (ECG) of adolescents in order to improve the indications for appropriate performance of physical exercise in schools.

Methodology

Descriptive, observational cross-sectional study

The study sample was comprised of pupils from Spanish second- and fourth-year compulsory secondary education (CSE) and second-year bachillerato (post-16 pre-Uni stage) attending the high schools Angeleta Ferrer i Sensat in Sant Cugat del Vallès, Banús in Cerdanyola del Vallès, Castellet in Sant Vicenç de Castellet, Montserrat Roig in Sant Andreu de la Barca, Poeta Maragall in Barcelona, INS Terrassa de Terrassa y Santa Teresa de Barcelona; they are private, state-subsidised private or state schools in the countries of el Baix Llobregat, el Vallès Occidental and el Bagès and the city of Barcelona in Catalonia.

The sample was determined randomly among the schools at which the teaching staff agreed to participate in the study between 2017 and 2018. The sample size was chosen with the same criteria used in the FRESC (*Factores de riesgo en estudiantes de secundaria de Barcelona*) [Risk Factors in Secondary Education Students of Barcelona]) survey for adolescents of the Agencia de Salud Pública de Barcelona [Public Health Agency of Barcelona] (ASPB), i.e., with a precision of 3%, 5% α error, an estimated proportion of 50% ($p = q = .5$) and a non-response of 20%. With these parameters, the sample size calculated was 1391 adolescents, 667 boys and 724 girls.

A structured and specific questionnaire about cardiovascular risk factors based on the health questionnaire of Catalonia (BMI, hypercholesterolaemia, hypertension, smoking and alcohol) was produced. In addition, a specific survey on exercise was conducted (adapted from the International Physical Activity Questionnaire [IPAC]

Serra-Grima et al., 2008; Craig et al., 2003) which gathered information on the type of exercise done by the pupils and their parents and its intensity together with the presentation of any symptoms related to physical exercise such as palpitations, sensation of dizziness or loss of consciousness. Information was also collected on the family history of cardiovascular risk factors (arterial hypertension, hypercholesterolaemia and diabetes) or heart disease, as well as the type of food intake, smoking and drinking alcohol.

The study was presented to the school councils and was approved at each school. A letter was sent to the families explaining the purpose of the research to secure their informed consent, stating that participation was voluntary. It was signed by all the families.

Once informed consent had been obtained, the pupils were given instructions on how to complete the questionnaire and did so in school hours under the supervision of their PE teacher. Following completion of the survey, they underwent an electrocardiogram in a room prepared for this purpose in the school.

A specific database was created for data collection and analysis and a pilot test was carried out before the study. The data collected were validated and quality control was conducted before the statistical analysis. A uni- and bivariate descriptive analysis of the data was performed. The distribution of normality was evaluated in all the variables by means of the Kolmogorov-Smirnov test. The categorical variables were compared by means of contingency tables using the chi-squared test. Student's t-test was used to compare quantitative and categorical variables. In all cases, the level of significance required was $p < .05$ ($\alpha = .05$). The SPSS S.26 statistical program was used.

Results

The characteristics of the pupils who participated in the study are displayed in Table 1.

No significant differences were observed between boys and girls in by-year distribution.

Table 1
Sample size, sex and age.

	Sex		Age	
	Quantity	Percentage	Mean	SD
Girls, 12-27 years	724	52 %	15.6	1.59
Boys, 13-20 years	667	48 %	15.55	1.48
Total	1391	100 %		

Table 2
Year of study.

Year	Age	*n*	%
2nd High School	17-18 years	197	14.20 %
4th CSE	15-16 years	668	48 %
2nd CSE	13-14 years	526	37.80 %
Total		1391	100 %

PA performed by the pupils and their parents

Time spent in PE classes was excluded from the pupils' PA tally. The boys performed significantly ($p < .001$) more licensed (federation) competitions than the girls, who in turn engaged in more in-school and out-of-school competition. The number of licensed pupils diminished significantly as of the age of 17 years ($p < .001$) (Tables 3 and 4).

Table 3
Physical exercise of pupils through competition outside PE classes.

	Boys	Girls
None	137 (20.5 %)	289 (39.9 %)
Out-of-school competition	145 (21.7 %)	173 (23.9 %)
In-school competition	83 (12.4 %)	131 (18.1 %)
Licensed	286 (42.9 %)	121 (16.7 %)
International	16 (2.4 %)	10 (1.4 %)
Total	667 (100 %)	724 (100 %)

Table 4
Hours of physical exercise a week by pupils outside PE lessons.

	Boys	Girls
None	35 (5.2 %)	56 (7.7 %)
Less than 2	65 (9.7 %)	61 (22.2 %)
Between 2 and 5	305 (45 %)	340 (47 %)
More than 5	262 (39.3 %)	167 (23.1 %)
Totales	667 (100 %)	724 (100 %)

The boys did a significantly greater number of hours of sport ($p<.001$).

The 15-to-16-year-old age group did most physical exercise.

The parents' physical activity was rated in terms of time spent, type of sport and whether it was competitive or not (Table 5).

Table 5
Physical exercise performed by the pupil's parents.

	2nd CSE	4th CSE	2nd *Bachillerato*
Regularly	18.4 %	12.3 %	10.2 %
Sporadically	35.9 %	36.5 %	22.3 %
Did no exercise	45.6 %	51.2 %	67.5 %

11% of the parents engaged in some type of competitive sport; 6.8% of fathers and 2.1% of mothers, with both competing in 2.5% of the cases.

When the hours spent by the pupils were cross-tabulated with the variable pertaining to the parents' participation in competitive sport, a statistically significant relationship was found ($p<.001$) inasmuch as the pupils who did most hours of exercise were the children of parents who engaged most in competitive sport.

Exercise-related symptoms in the study pupils.

Isolated palpitations: 283 (39.1%) girls and 158 (23.7%) boys reported having presented episodes on some occasion. Forty-seven (47) (6.5%) girls and 30 (4.5%) boys saw a doctor for this reason.

Dizziness and/or loss of consciousness. One hundred and twenty-five (125) (17.3%) girls and 52 (7.8%) boys presented some episodes of dizziness, although none of them actually lost consciousness. Of the participants that presented a sensation of dizziness, 100 (13.8%) were girls and 49 (7.3%) boys and had to stop exercising with no major consequences.

Family cardiac disease. Father with cardiac problems: 12.8%. Mother with cardiac problems: 8.6%. Siblings with cardiac problems: 2%

Cardiac disease in the pupils: Seven hundred and eight (708) (97.8%) girls and 639 (95.8%) boys had no type of known pathology. Sixteen (16) (2.2%) girls and 28 (4.2%) boys stated that they had some type of heart condition that had been reported to the school PE teacher.

ECG. One thousand (1,000) 12-shunt records were taken with a portable device. The entire sample was not included for technical reasons. Unspecific repolarisation and/or early repolarisation disorders were recorded in 59 cases. The characteristics of these disorders are frequent and did not require any further examination to rule out the existence of organic heart disease. In three cases, repolarisation alterations were recorded in the right precordial leads (V1-V3) of the type of repolarisation that occurs in children and normally persists until the age of 7 years, although there are exceptions.

Incomplete right bundle branch block was recorded in nine cases, and a prolonged PR interval in two cases, which reverted to normal with a mild increase in heart rate.

Cardiovascular risk factors. 2.3% reported arterial hypertension, 7.3% hypercholesterolaemia and 2.3% diabetes.

Smoking. 90.1% of the girls and 93.4% of the boys had never smoked. Of the remaining percentage, more girls than boys ($p<.05$) were found to smoke and smoking increased in the group of pupils aged 17 years and above ($p<.001$).

Table 6
Number of cigarettes a day reported by the pupils.

No. of cigarettes	Boys	Girls
1-2	16 (2.4 %)	1 (0.1 %)
4-5	9 (1.3 %)	17 (2.3 %)
5-10	6 (0.9 %)	14 (1.9 %)
15	2 (3 %)	2 (0.3 %)
Occasional	1 (0.1 %)	4 (0.6 %)
Total:	667 (100 %)	724 (100 %)

Obesity. BMI was below 18 in 296 (21.3%) of the cases and above 30 in 26 (1.9%). A total of 97 of the 1254 pupils were above 25. BMI was above 30 in 26 (1.9%) of the cases, meaning overweight/obesity. No significant differences were observed between boys and girls.

Table 7
Distribution of BMI in the pupils.

BMI	Boys	Girls
<18 insufficient weight	146 (21.9 %)	150 (20.7 %)
18-25 normal weight	455 (68.2 %)	516 (71.3 %)
25-29 pre-obesity	51 (7.6 %)	47 (6.5 %)
>30 obesity	15 (2.2 %)	11 (1.5 %)
Total	677 (100 %)	724 (100 %)

Drinking alcohol. Most of the pupils drank occasionally and at weekends, more specifically 20.8% of the boys and 24.3% of the girls. 75.9% of the boys and 70.3% of the girls were non-drinkers. Although the ratio was not significant, there was a clear trend towards greater alcohol consumption among the girls ($p < .07$), as has also been observed in recent studies. This trend was additionally reflected in drunkenness among the drinkers, with 15.1% of the boys and 22.2% of the girls having been drunk in the previous few days. As the pupils become older, alcohol consumption increased significantly ($p < .001$), and 58.9% of the *bachillerato* pupils drank alcohol.

Discussion

Physical exercise, diet and the absence of bad habits, particularly smoking which is the most common one, are basic cornerstones for the promotion and maintenance of health. There is a broad corpus of scientific evidence demonstrating that the coexistence of different risk factors begins in childhood (Newman et al, 1986; Berenson, 2009; Henriksson et al., 2017) and hence the importance of changing pupils' lifestyles, particularly with regard to physical exercise and eating habits. An increase in physical activity and a reduction in sedentary time are positively related to cardiometabolic risk and other major risk factors (Väistö et al., 2018; Sanyaolu et al., 2019; Rendo-Urteaga et al., 2015).

The prevalence of cardiovascular risk factors in Spain is equal to or greater than the mean of other European countries and is on the increase. This is one of the arguments for promoting prevention measures in school years so that pupils will continue to exercise once they have left high school (Lobos & Brotons, 2011).

Most state and private school dining facilities are supervised by nutritionists as the first link in the chain of health promotion measures. The second link, physical exercise, does not receive the attention it warrants. Two hours a week is totally insufficient, and teaching staff admit that they have to contend with limitations in implementing exercise programmes with the twofold function of being educational and improving health and physical qualities.

To make up for this drawback, out-of-school sports and activities intended to encourage pupils to engage regularly in physical activity were fostered. Further work is required in order to extend this base by including more girls and boys who due to a lack of motivation or physical limitations are not able to make the most of all the known benefits delivered by sport as a global, educational and recreational therapy.

Physical exercise is a planned, structured and repetitive activity which, besides helping to improve physical qualities, has gained fresh recognition in view of the evidence of its favourable effect on cognitive function and memorisation and learning capacity in children and adolescents (Bueno, 2017; Mora, 2013; Manes, 2015).

The information on physical exercise that is performed by parents, since their example and motivation adolescents will benefit, which entails an education with a healthy lifestyle.

The quantification of physical exercise in energy expenditure to further health promotion has its limitations despite the contribution of questionnaires produced with this objective in mind. A questionnaire that was administered to former athletes who had retired from elite competition was used to evaluate activity in terms of hours a week along with the IPAC which is a reference point and has been validated.

Most of the study pupils did between two and five hours of exercise a week, below the recommendations of the American Academy of Pediatrics which considers that the age group between 6 and 17 years should do at least one hour a day of moderate activity, and if it is intense then it should be at least three days a week. 26.1% of American adolescents do no physical activity and 15.4% are sedentary (Lobelo et al, 2020). The lowest levels of physical exercise are in adolescents and groups with special needs. One relevant piece of data is that physical inactivity increases with age. In the pupils studied, 39.3% of the boys and 23.1% of the girls fulfilled the recommendations of allotting at least one hour a day to physical exercise.

Habits acquired during school years are not always maintained when pupils leave school. Nevertheless, inclusive physical exercise programmes which may be beneficial for pupils with more limited physical qualities or some type of doctor-supervised condition should be promoted to ensure adherence.

Exercise done in school and out-of-school sports does not usually involve very high physical demands and the rules that govern participation in team or individual sports make it possible in theory to regulate the effort made by adolescents. These rules foster inclusion, which is one of the priority objectives in sport.

Risk in sports is unusual, particularly if the training method is correct and proper preparation is ensured (Serra-Grima, 2015). Nevertheless, in order to ensure pupil safety and for PE teaching staff to be able to do their job properly, such staff should have extensive information about the pupils' family and personal background available. This was the case with the population analysed as shown in the questionnaire which was produced. Any background or history of cardiovascular diseases in first-generation members and whether or not they do physical exercise was ascertained. The pupils were asked if they had ever presented symptoms such as chest pain, palpitations, sensation of dizziness or loss of consciousness, and their answers, as well as the medical visit, did not yield any information that would lead to a recommendation for them to temporarily give up sport. 83.7% of the pupils had never had a sensation of dizziness

or loss of consciousness. Fifty-two (52) (7.8%) boys and 125 (13.8%) girls had to stop, although they recovered spontaneously and required no further measures.

PE teachers may not be able to identify the significance of effort-related symptoms that might not be normal. If pupils report symptoms such as palpitations, dizziness or loss of consciousness, the diagnosis must be made by a doctor. As shown in the table, only 4.4% and 6% of the pupils who reported palpitations actually went to see a doctor, and the episodes were regarded as benign in all cases. The sensation of palpitations reported by them cannot strictly speaking be interpreted as arrhythmia because they presented transiently at the beginning or at the end of exercising and fit more within the type of symptoms that may occur due to changes in pace or even in posture. There was no suspicion of actual arrhythmia in any case and generally speaking it is accompanied by other symptoms. Fifty-two (52) (7.8%) of the boys and 125 (17.3%) of the girls presented some type of episode, although none of them ever lost consciousness.

A total of 83.7% had never experienced a sensation of exercise-related dizziness or loss of consciousness. In the 49 (7.3%) boys and 100 (13.8%) girls who reported a sensation of dizziness, the episodes occurred after the effort made, a fairly common phenomenon when exercise is discontinued abruptly; none of them required medical care.

The inclusion of the ECG in the study is in line with the recommendations of the European Society of Cardiology (Corrado et al., 2005) for pre-participation screening to do sport. The drawback is the false positives that generate doubts, which may involve the performance of complementary examinations to be able to rule out the presence of structural heart disease. Of the 59 ECG in which alterations were recorded, most of them were non-specific repolarisation disorders, a relatively frequent finding in young people who do sports. In the pupils who presented other alterations such as incomplete right bundle branch block, the ECG was normal which meant the presence of structural heart disease could be ruled out. The two cases in which a prolonged PR interval was recorded reverted to normal with slight increases in heart rate, suggesting a functional alteration. In the absence of a family or personal background of exercise-related symptoms and an ECG with alterations of scant clinical value, the likelihood of risk is low. This enables PE teaching staff or coaches to do their job more safely and confidently.

Tackling obesity in both adults and adolescents is one of the objectives of community health programmes. Programmes for primary prevention, consisting of promoting physical exercise, and secondary prevention, involving education intended to maintain physical exercise and good eating habits in adult life, have been run (Sanyaolu et al., 2019). Promoting physical exercise and reducing sedentary lifestyles are factors for lessening cardiometabolic risk. 7.6% of the boys and 6.5% of the girls in the pupils studied were overweight. A BMI greater than 30 is regarded as obesity, and 2% of the boys and 1.5% of the girls were above this figure (Table 7).

Studies conducted in adolescents to ascertain the prevalence of smoking in Spain indicate that it has diminished. There was a bracket ranging between 8.5% and 13.3% in boys and between 12.7% and 16.4% among girls. These results corresponded to the years between 1993 and 2008 (Villalbí et al., 2012). In the group of adolescents that were assessed, 93.4% of the boys and 90.1% of the girls were non-smokers, lower percentages which confirm the data obtained from the abovementioned study that pointed to a trend towards a reduction in smoking.

With regard to not drinking alcohol, also one of the mainstays of health, 75.9% of the boys and 70.3% of the girls stated that they do not drink. Those who do are occasional and weekend drinkers. However, it was found that the girls drank more and reported more episodes of drunkenness at the weekend. The results of a study conducted by Sánchez-Quejia et al. (2015) in three series point to a reduction in the consumption of wine and spirits between 2002 and 2010 and a rising trend in episodes of drunkenness, although some more recent data also indicate an increase in drinking. The questionnaire about alcohol consumption only asked the generic question without specifying the type of alcohol.

The study's objective was not to compare years or schools which is why the sample was selected globally, bearing in mind that not all pupils who complete 4th CSE go on to higher secondary education. Nevertheless, the sample size meant the results were representative of all the pupils in the research team's setting.

Conclusions

Promoting physical activity and education in order to embrace a healthy lifestyle should be initiated during school years and with a view to ensuring continuity in adulthood.

The overall information from the pupils about their personal and family background and level of physical activity performed makes it possible to take measures to embark upon a health education programme that will help with improving eating habits, performing physical activity and eliminating bad and unhealthy habits.

PE teachers or the people running out-of-school sports need to know whether pupils present effort-related symptoms, if they do whether such symptoms are significant and whether they have had a normal medical check-up by their paediatrician or GP. If in addition pupils have an ECG that rules out the existence of structural heart disease with a likelihood of risk, then PE teachers can do their job knowing that a serious cardiovascular event will only occur in exceptional circumstances.

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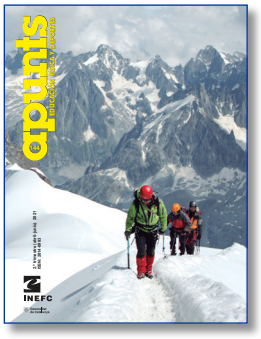

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Blood Pressure Responses in Hypertensive Women to Water Aerobics

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Abstract

Background: To evaluate acute blood pressure (BP) responses of hypertensive women during and 20 min after continuous (CON) and interval (INT) water aerobics sessions. *Methods*: Nine treated hypertensive women (61.22 ± 2.91 years, body mass index 28.70 ± 4.45 kg.m^{-2}) performed two randomized water-based exercise sessions (32 min): CON (13-14 Borg Scale) and INT protocol (2 min at 17 Borg Scale with 2 min of active recovery at index 9). BP was measured 20 min before, during and after exercise. Repeated measures two-way ANOVA with Bonferroni was used ($\alpha = .05$). *Results*: BP responses did not differ between the protocols ($p > .05$). For diastolic BP, halftime and endpoint exercise were significantly lower than all four recovery points measured ($p < .001$). A trend in p value was observed for systolic BP ($p = .051$), however, no differences between the time-points were found. No significant differences were observed for time-points in mean BP ($p > .05$).
Conclusion: Hypertensive women do not present significant difference for the BP values between CON and INT protocols, and no post-exercise hypotension was observed within 20 minutes of recovery. Thus, both protocols appear to be safely performed by treated hypertensive women.

Keywords: Aquatic exercise, Arterial hypertension in women, Blood pressure, Interval exercise, Postexercise recovery

Introduction

Hypertension has high medical and socioeconomic costs, mainly due to its complications, such as cerebrovascular and coronary artery disease, heart failure, chronic renal failure, and extremity vascular disease (Whelton et al., 2018). Data from 2013-2014 show that 33.5 % of adults aged 20 and over were diagnosed with hypertension in United States, resulting in more than 360,000 American deaths included high blood pressure (BP) as a primary or contributing cause (Mozaffarian et al., 2015), which means almost 1,000 deaths each day.

In the general population, exercise protocols with a richer variety of motor skills are more likely to favor participant interaction and engagement, and improve cardiac responses (Castañer et al., 2017). In addition, regular aerobic exercise reduces BP along training programs and the hypotensive effect is greater the higher the initial BP (Pescatello et al., 2004). Decreases in catecholamines and total peripheral resistance, improved insulin sensitivity, and alterations in vasodilators and vasoconstrictors are some of the postulated explanations for the antihypertensive effects of exercise. Emerging data suggest genetic links to the BP reductions associated with acute and chronic exercise (Pescatello et al., 2004). For this reason, increased physical activity with a structured exercise program has been widely indicated as an efficient non-pharmacological alternative for the hypertensive population (Whelton et al., 2018).

Physical exercise in the aquatic environment can be highlighted as a suitable modality for this population. It is practiced specially by women, whose responses to exercise deserve attention in literature, since they present physiological, morphological, and psychological differences in comparison to men (Gómez-Jiménez & López de Subijana-Hernández, 2016; González Robles et al., 2017; Granda Vera et al. 2018). Moreover, immersion may induce a reduction in BP in normotensive individuals at rest (Srámek et al., 2000). This reduction occurs due to an immediate redistribution of blood from the periphery to the central region of the body, causing an increase in cardiac output, with a consequent increase in renal blood flow, and which, concomitantly with a decrease in plasma renin activation and an increase in the peptide concentration atrial natriuretic, cause reduction of BP values (Rim et al., 1997). Moreover, in the last few years some studies have observed the chronic effect of aquatic training on BP responses (Guimarães et al., 2014). A 36-week water-based exercises program was able to promote a reduction of 36 mmHg in systolic BP (SBP) and 12 mmHg in diastolic BP (DBP) in resistant and medicated hypertensive patients (Guimarães et al., 2014).

The chronic reduction in BP with regular exercise seems to be partially explained by acute BP decreases after a session of exercise. Studies have demonstrated aerobic physical exercises performed on land present a significant acute reduction in post-exercise BP responses (MacDonald et al., 1999), a phenomenon known as post-exercise hypotension (PEH). In addition, different protocols of water-based exercises have been investigated in order to verify the presence of PEH in normotensive and hypertensive individuals (Bocalini et al., 2017; Cunha et al., 2017; Cunha et al., 2018; Pinto et al., 2017; Pontes-Júnior et al., 2008; Rodriguez et al., 2011; Sosner et al., 2016; Terblanche and Millen, 2012). Regarding acute PEH in aquatic exercise sessions, Rodriguez et al. (2011) and Pinto et al. (2017) evaluated the BP 60 min after water-walking and water-based concurrent training in normotensive participants, respectively, while Cunha et al. (2012, 2017), Pontes-Junior et al. (2008), and Bocalini et al. (2017) from 10 to 90 min after water-based aerobic sessions in individuals with prehypertension and hypertension. Regarding 24h-PEH, Cunha et al. (2018) evaluated it after water-based exercises in normotensive women over 65 years, and Terblanche and Millen (2012) and Sosner et al. (2016) in individuals with prehypertension and hypertension. From these studies, Sosner et al. (2016) was the only one who employed an interval water-based protocol; however, their purpose was to compare PEH from different environments (dry land versus water).

In addition to the environment in which exercise is performed, another factor that may influence the PEH phenomenon is the intensity of the training session in healthy (Angadi et al., 2015) and hypertensive (Ciolac et al., 2009) individuals. Ciolac et al. (2009) analyzed the BP responses after a 40 min continuous (60 % reserve HR) and interval (1 min 80 % and 2 min 50 % reserve HR) cycling protocol performed on land. The authors observed a significant reduction in PEH 24h-systolic and nighttime SBP and a trend to reduce nighttime DBP in the interval protocol. However, the effects of different intensities during water-based exercise protocols (i.e., continuous moderate intensity versus interval high intensity) on PEH in individual with hypertension remain unclear in the literature. The optimal training intensity needs to be better defined to optimize the BP lowering capacities of exercise.

Therefore, the purpose of the present study was to evaluate acute BP responses of treated hypertensive women during and 20 min after continuous and interval water-based exercise protocols. We hypothesized that higher intensity exercise could induce greater reduction in BP responses, evidencing a significant acute PEH.

Methods

Participants

The sample was composed by nine women, volunteers, diagnosed with hypertension by a physician during a clinical evaluation following the cut-off points: SBP ≥ 140 mmHg and DBP ≥ 90 mmHg. Eligibility criteria were: 1) diagnose of hypertension for at least 6 months; 2) be physically active for at least 6 months; 3) treated with medication but not β-blockers; 4) not smoke; 5) no physical limitations; 6) should be familiarized to aquatic exercises.

Upon starting the research, all participants signed an informed consent form. The study was approved by the Research Ethics Committee of the Federal University of Rio Grande do Sul, Brazil (2008168).

Experimental procedures

The present is a pilot study, with a crossover trial design. Each woman participated in three sessions, with a minimum interval of 48h between sessions. The first session was designed to familiarize and characterize the participants, and the other two sessions to the experimental protocols, performed at random order. The experimental protocols corresponded to a continuous (CON) and interval (INT) water-based exercise sessions. Heart rate (HR) and BP were measured 20 min before, during, and 20 min after exercise, with one measure every 5 min. Figure 1 shows the schematic flowchart of the data collection protocol.

Participant characteristics

Participants were 61.22 ± 2.91 years, 72.00 ± 16.40 kg, 157.72 ± 7.55 cm, body mass index 28.70 ± 4.45 kg.m^{-2}, considered as slightly overweighted. The hypertension was pharmacologically controlled with calcium channel blockers: $n = 1$; angiotensin converting enzyme inhibitors: $n = 5$; diuretic: $n = 3$.

Characterization and familiarization

In the initial session, body mass (kg) and height (m) were measured using a scale and a stadiometer (Filizola, São Paulo, Brazil). In this session, the participants were familiarized with the BP device, the 6-20 Borg Scale (Borg, 1990), and with the exercises. Participants were instructed to observe the degree of tension and fatigue in their muscles, shortness of breath and chest pain. The 15-point scale was explained considering it incorporates nine verbal descriptors ranging from "no exertion at all" (RPE 6) to "maximal exertion" (RPE 20). A rating of 6 corresponds to the level of exertion

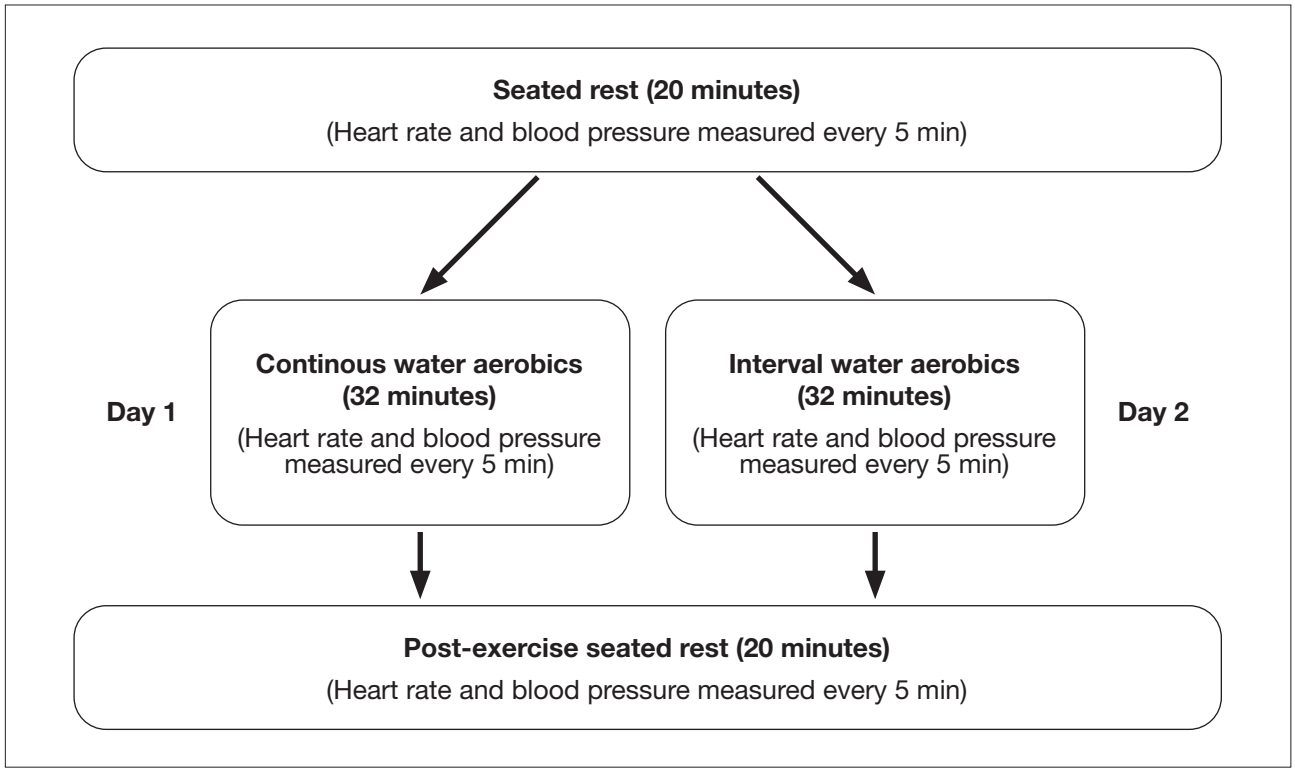

Figure 1
Schematic flowchart of the random data collection protocol.

experienced during a quiet seated rest, whilst a rating of 19 approximates maximal or near-maximal physical exertion (Borg, 1990). The scale (60 × 90 cm banner) was placed out of the pool in front of the participant during the familiarization e protocol sessions. All the details of execution and amplitude of the movements were explained and then, the women performed the exercises at a comfortable pace. The familiarization session was finalized with the drawing of the execution order of the exercise protocols (CON or INT).

The HR (HR monitor model F6TM; Polar, Kempele, Finland), SBP and DBP (BP monitor ABPM-04 recorder with mean arterial pressure optical interface, Meditech, Budapest, Hungary, respectively) were monitored before, halftime exercise and after the protocols. The mean BP (MBP) was calculated using the formula MBP = DBP + [0.333 * (SBP-DBP)].

Interventions and outcome measurements

Regardless of the protocol, the participants always started remaining at rest out of the water, in the seated position for 20 min, with their feet and arms supported, and the chair positioned at the edge of the pool near the stairs. The HR and BP measurements were performed every 5 min during this period. For the analysis of the resting situation, the values of the 10th minute of the seated rest were used.

Water-based exercise protocols were performed during 32 min with the intensity prescribed by the rating of perceived exertion (RPE) based on 6-20 Borg scale (Borg, 1990). In the CON protocol, the intensity was controlled by RPE between 13 and 14 (somewhat hard). In the INT protocol, eight 2 min bouts at RPE 17 (very hard) were interspersed by 2 min of active recovery at RPE 9 (very light). Both CON and INT protocols were composed by two blocks of four exercises, each one performed for 4 min, totaling 32 min of exercise. The following sequence of water-based exercises were used: stationary running with simultaneous elbow flexion and extension, cross country skiing with simultaneous shoulders flexion and extension, jumping jacks with simultaneous shoulders abduction and adduction, and frontal kick up to 45º with simultaneous arms pushing the water forward. This protocol model was previously used in the study by Kruel et al. (2009) whose objective was to analyze the cardiorespiratory responses between protocols. The experimental sessions were always applied by the same instructor to a maximum of two participants per period, without background music.

The HR and BP evaluations during the protocols were performed at 16 min (halftime) and immediately at the end of session (endpoint). Protocols were performed in a pool with a depth variation of 0.95 to 1.30 m, allowing each of the participants to be immersed in the xiphoid process depth. The water temperature was maintained between 31° and 32° C.

Similar to the initial phase, after the end of the exercise protocol the participants rested out of the water, in the seated position for 20 min, with their feet and arms supported, and the chair positioned at the edge of the pool near the stairs. The HR and BP measurements were performed every 5 min during this period. For the analysis of the post-exercise seated situation, the values of the 10th minute of the seated rest were used.

Statistical analysis

Descriptive statistics (mean ± standard deviation) and Shapiro-Wilk's normality test were used. Repeated measures two-way ANOVA (protocol and time-points) with Bonferroni *post-hoc* was used to compare the outcomes between the tested situations. When the interaction was significant, the F test was performed for each main effect. The effect size for each main effect was calculated by ηp^2. The significance level was set to $\alpha = .05$. All statistical tests were performed in the Statistical Package for Social Sciences software (version 20.0 for Windows; SPSS Inc., Chicago, IL, USA).

Results

Blood pressure and heart rate responses at rest

The pre-exercise rest situation for day 1 and day 2 were similar. The mean values of SBP, DBP, MBP, and HR at pre-exercise rest were 121.88 ± 12.87 mmHg, 74.66 ± 9.95 mmHg, 90.40 ± 8.97 mmHg, and 81.41 ± 16.92 bpm for the interval session, respectively, and 121.11 ± 14.34 mmHg, 72.55 ± 8.54 mmHg, 88.74 ± 9.57 mmHg, and 83.23 ± 18.86 bpm for the CONT, respectively.

Blood pressure and heart rate responses during exercise

Regarding the protocols, the HR response was significant higher for INT compared to CON (halftime: 118.19 ± 26.32 bpm vs 106.51 ± 25.57 bpm, endpoint: 130.14 ± 28.49 bpm vs 116.29 ± 23.82 bpm, respectively; $p = .021$; $\eta p^2 = .508$; Figure 2). Blood pressure responses did not differ between the protocols during exercise (i.e., halftime and endpoint) ($p > .05$; Figure 3).

Blood pressure and heart rate responses post-exercise

The analyses of water-based exercises at rest (min 10), exercise (halftime and endpoint) and during recovery

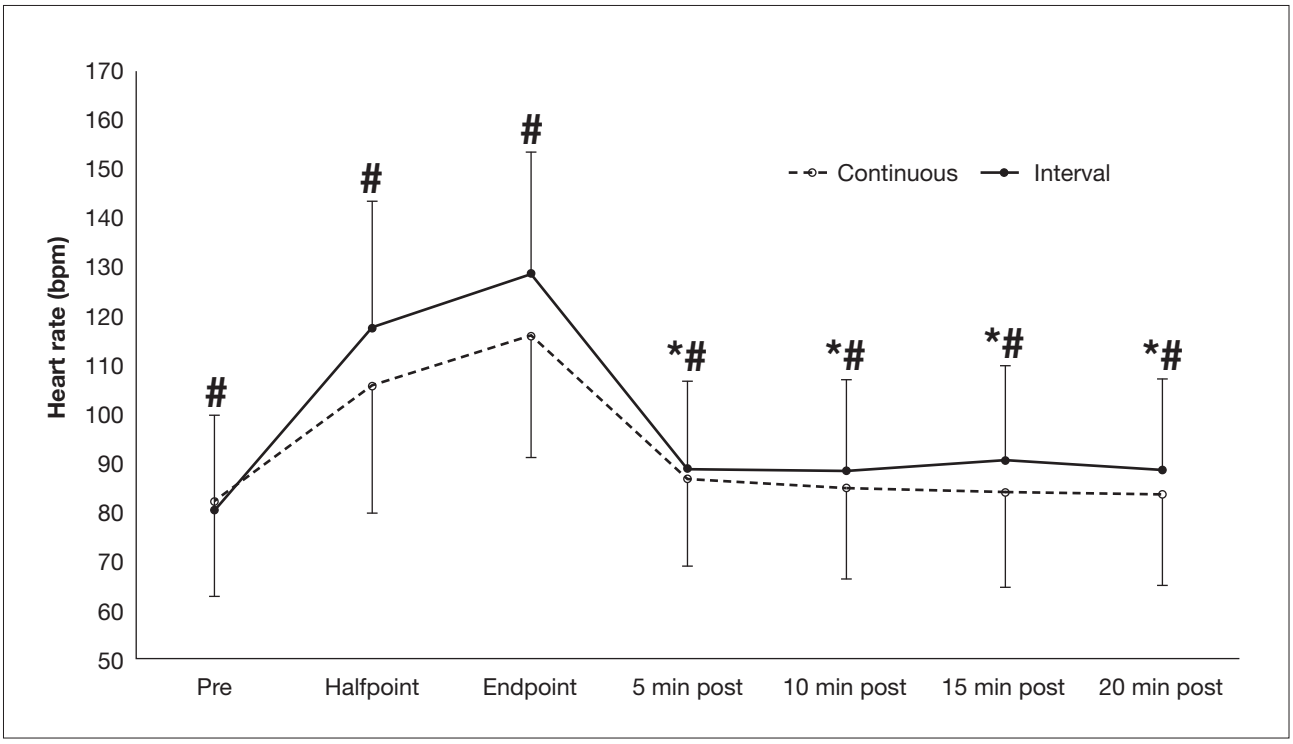

Figure 2.
*Pre-exercise, halftime, endpoint and 20-min post-exercise heart rate responses for continuous and interval water-based exercises sessions. Data are presented as mean (SD). #p<.05 different from continuous protocol. *p<.05 different from exercise endpoint.*

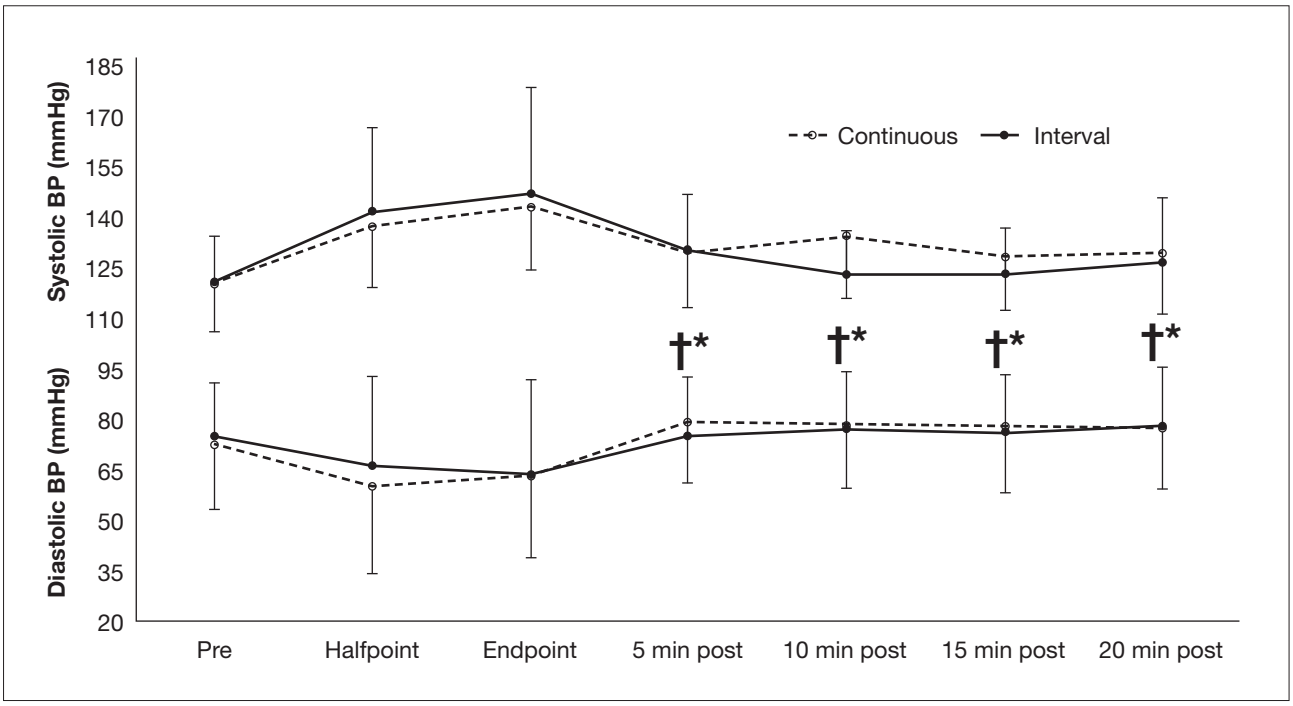

Figure 3.
*Pre-exercise, halftime, endpoint and 20-min post-exercise systolic and diastolic blood pressure (BP) responses for continuous and interval water-based exercises sessions. Data are presented as mean (SD). †p<.05 different from exercise halftime. *p<.05 different from exercise endpoint.*

(5, 10, 15, 20 min) are presented in Figure 2 and 3. The main effect time-point presented a significant difference for DBP ($p < .001$; $\eta p^2 = .699$) and HR ($p < .001$; $\eta p^2 = 0.720$). For DBP, both exercise measurements (halftime and endpoint) were significantly lower than all four recovery points measured. For HR, the endpoint exercise measurement was significantly higher than pre-exercise as well as all four recovery points measured. Regarding SBP, a trend in p value was observed ($p = .051$; $\eta p^2 = .347$), however, no differences between the time-points were found with post-hoc analysis. Finally, no significant differences were observed for time-points in MBP ($p > .05$; CONT and INT: rest pre-exercise: 88.7 ± 9.6 mmHg and 90.4 ± 9.0 mmHg, exercise halftime: 85.8 ± 10.5 mmHg and 92.0 ± 14.0 mmHg, exercise endpoint: 89.9 ± 10.1 mmHg and 91.5 ± 14.6 mmHg, post5min: 96.0 ± 8.5 mmHg and 93.8 ± 9.7 mmHg, post10min: 96.9 ± 11.2 mmHg and 92.9 ± 8.9 mmHg, post15min: 94.5 ± 12.0 mmHg and 91.9 ± 9.2 mmHg, post20min: 94.8 ± 10.4 mmHg and 94.4 ± 11.0 mmHg, respectively).

Discussion

The purpose of the present study was to evaluate BP responses of treated hypertensive women in continuous and interval water-based exercise sessions. The main findings of the present study were the absence of significant difference between the protocols (continuous vs. interval) for the BP variables, regardless the higher HR values during the exercise interval session. Another important finding is that there was no post-exercise hypotension within 20 min of recovery, in contrast to our hypothesis.

The literature reports a hypotensive post-aquatic exercise response in hypertensive individuals, which was not verified in the present study. Cunha et al. (2012, 2017), Pontes-Junior et al. (2008), and Bocalini et al. (2017) evaluated the PEH from 30 to 90 min of recovery after water-based exercise sessions. Cunha et al. (2012) evaluated elderly hypertensive women 30 min after a moderate intensity (RPE ≈13) and predominantly aerobic (40 min) water-based exercise session. The SBP decreased significantly only 30 min after the exercise session (Baseline: 135.5 mmHg; 30 min: 126.9 mmHg), while DBP decreased significantly from 76.1 at rest to 74.8, 72.6, and 72.8 mmHg at minutes 10, 20 and 30, respectively. A similar protocol was applied for the same research group in a crossover clinical trial (Cunha et al., 2017) and the results showed at 10 min after exercise, SBP and DBP significantly declined 7.5 mmHg (6.2 %) and 3.8 mmHg (5.5 %), respectively, compared to a control session (no exercise for 45 min), but at 20 and 30 min after exercise, BP were similar in both exercise and no-exercise sessions. In the present study only 20 min of recovery were evaluated and no PEH effect was observed after a water-based continuous or interval exercise session.

Pontes-Junior et al. (2008) evaluate hypertensive individuals 90 min after running in water and dry land (at 50 % of VO_{2peak}, 45 min). SBP was reduced as early as 10 min post-exercise and presented a greater reduction at 30 min after water-based exercise (142 vs. 107 mmHg). DBP was reduced as early as 5 min after water-based exercise and presented a greater reduction at 30 min (93 vs. 76 mmHg). The greater reduction of mean arterial pressure was observed at 30 min after water-based exercise (109 vs. 86 mmHg).

This disagreement with the previous studies performed in the aquatic environment may be related to the population of the present study of hypertensive women controlled with medication, since is well-known the PEH is larger the higher the initial BP value (Pescatello et al., 2004). The participants of the present study presented a mean SBP and DBP at pre-exercise of 121.50 ± 13.22 mmHg and 73.61 ± 9.06 mmHg, respectively, lower than the SBP and DBP values found in the studies of Pontes-Junior et al. (2008) (142 ± 2 mmHg and 93 ± 2% mmHg, respectively) and Cunha et al. (2012) for the control and experimental groups (SBP: 138.25 ± 12.78% mmHg and 135.46 ± 7.42 mmHg, respectively; DBP: 74.90 ± 7.31% mmHg and 76.09 ± 6.49 mmHg, respectively).

In addition, Bocalini et al. (2017) evaluated the effect of water- and land-ergometric exercise (75 % VO_{2max}, 45 min) sessions on PEH of healthy normotensive, treated or untreated hypertensive patients. At 90 min after the exercise session, the prevalence of hypotension was significantly higher in water than in the land-based protocol. Moreover, more pronounced reductions in SBP and DBP were observed in the untreated patients compared to treated and normotensive subjects. It is interesting that the ratio of treated patients compared to those not treated with medication also interferes with initial BP values reflecting the magnitude of PEH. In the present study, because women were pharmacologically treated, the initial BP values were lower, resulting in an absence of PEH in the first 20 min post-exercise.

Furthermore, other studies evaluated 24h-post water-based exercise. Terblanche & Millen (2012) determined and compared the magnitude and duration of PEH after an acute session of concurrent exercise in water and on dry land (60 and 80 % VO_{2peak}, RPE 12–16, 55 min) in individuals with pre-hypertension and hypertension. The PEH response for SBP lasted for 9 h after water-based exercise session. Besides comparison of BP responses of hypertensive individuals following water-based exercises (high-intensity protocol), Sosner et al. (2016) also compared moderate-intensity continuous exercise (24-min, 50 % peak power output), and high-intensity interval exercise (two sets of 10-min with bouts of 15-sec 100 % peak power output interspersed by 15-sec of passive recovery) on dry land in stationary cycle. Dry land and immersed high-intensity exercise induced a 24-h BP

decrease (SBP: -3.6 and -6.8 mmHg, DBP: -2.8 mmHg and -3.0 mmHg, respectively).

Ciolac et al. (2009) also investigated the effect of intensity on PEH in middle-aged hypertensive participants, comparing 40 min of dry land cycle ergometer exercise in continuous (60 % reserve HR) and interval (2 min at 50 % reserve HR with 1 min at 80 %) protocols. The interval protocol resulted in significant reduction on PEH 24h-systolic and nighttime systolic and tended to reduce nighttime diastolic. Therefore, the present study seems to be the first to investigate the blood pressure responses of treated hypertensive women in continuous and interval water-based exercise sessions, whose results showed that exercise sessions up to 20 min there was no PEH responses.

Nonpharmacological strategies to reduce BP was analyzed in a meta-analysis of randomized controlled trials (Herrod et al., 2018). Results from this study shown that three months of exercise-based lifestyle intervention, consisting of aerobic, resistance or combined exercise training, may produce a reduction in BP of approximately 5 mmHg SBP and 3 mmHg DBP in participants with a mean age of 65 or over. These results indicated lifestyle intervention alone cannot be recommended as a sole treatment for hypertension but may serve as a useful adjunct to pharmacotherapy because it is often the first line in management in treatment guidelines (Whelton et al., 2018).

An important limitation of the present study is the absence of an immersion control session in the aquatic environment, as well as the absence of a control group with normotensive individuals, which would help in understanding the specific BP responses of the water-based exercise protocols and the effect of the medications used. Another important limitation was the post-exercise recovery time of only 20 min. However, this was the proposal of the study, to study patients with hypertension as well as to see if the PEH phenomenon would occur immediately after the protocols. Finally, our pilot study has a low sample size which may restrict a wider generalization of the findings.

Conclusions

We conclude that controlled hypertensive women achieve higher HR values in the interval aquatic exercise session and do not present significant difference for the blood pressure values between the protocols. In addition, there was no PEH within 20 minutes of recovery for both water-based sessions.

As a practical application, we suggest that the continuous and interval water-based exercise sessions tested in this study can be performed by hypertensive individuals controlled with cardiovascular safety. Further studies should be performed by testing different intensities and exercise volumes in the water environment, to clarify which protocol could potentiate the reduction of blood pressure values in controlled hypertensive individuals and, therefore, provide a good theoretical basis for a safe prescription of aerobic training for this population.

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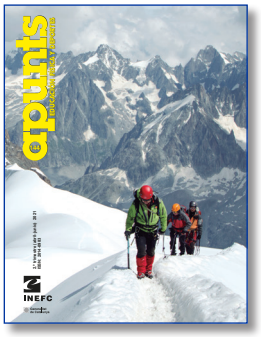

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Training Physical Education Teachers in the Use of Technological Applications

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Abstract

The inclusion of Information and Communication Technologies (ICT) in the educational setting requires teaching staff to have a sufficient level of digital competence (DC) to be able to teach this technology to students. Paradoxically, the literature shows an emerging trend towards the study of DC whereas the specific use of technology tools is tapering off, particularly in the area of physical education (PE). Therefore, the objective of this paper was to evaluate the actual use of educational applications by future PE teachers. To this end, the CUTDEF (*Cuestionario sobre conocimiento y uso de las TIC por los y las docentes de EF*) [Questionnaire on the Knowledge and Use of ICT by PE Teachers], previously validated by a panel of experts, was administered to 155 students at the University of Valencia. The results showed that few applications are used and are limited to office automation tools (word processor, spreadsheet and presentations) and that all the possibilities provided by the use and the potentialities of other applications or tools available online are not leveraged. It is concluded that trainee PE teachers present an average knowledge and use of information and communication management tools, basically as Google users, while they have made little headway in the creation of generic and specific digital content about PE. An improvement in this area is one of the challenges to be addressed in order to accomplish better development of DC in PE.

Keywords: digital competence, technological applications, ICT, physical education, teaching staff

Introduction

Information and Communication Technologies (ICT) have brought about a change of mindset both in the way that students learn and also how teachers teach based on the appropriation of content, the development of competences and the creation of attractive venues for interaction and knowledge exchange (Castro-Lemus & Gómez, 2016). This is designed to make learning more effective, efficient, innovative and attractive, thereby reducing the school drop-out rate (Calero, 2019; Colas-Bravo et al., 2018). Indeed, some authors suggest that the operative expression should be Learning and Communication Technologies (LCT) (Prat & Camerino, 2012; Lozano, 2011).

Nevertheless, implementing this approach calls for a change in the form of teaching whereby teaching staff transition from knowledge depositories to transmitters of information and designers of learning situations using new materials and multimedia resources that will be made freely accessible to students via the Internet (Prat & Camerino, 2012). This new approach requires teachers to have sufficient digital competence to be able to provide students with the training called for nowadays (Díaz, 2015).

The DC involves the creative, critical and secure use of ICT and therefore requires knowledge related to accessing sources and processing information, content creation, security and problem-solving (*Instituto Nacional de Tecnologías Educativas y de Formación del profesorado*, INTEF, 2017). Student DC is a requirement of Spanish legislation (Royal Decree 126/2014 of February 28, which establishes the basic syllabus for Primary Education, and Royal Decree 1105/2014, of February 24, which establishes the basic syllabus for Compulsory Secondary Education and Baccalaureate) so that they can write, present documents and search for information as well as perform tasks and further their learning. Little research has been done in this area since the enactment of the current education law (*Ley Orgánica 8/2013, de Mejora de la Calidad Educativa* [Organic Law 8/2013 on the Improvement of Educational Quality], LOMCE) since the bulk of the research conducted to date took place while the *Ley Orgánica 3/2006, de Educación* [Organic Law 3/2006 on Education] (LOE) was in force. This affords added value to this paper.

In terms of background, several authors (Suárez-Rodríguez et al., 2012) showed that teachers' technological competence (use of computers, basic computing applications and ICT and communication resources) is the same as a regular or basic user of technological resources such as word processors, basic Internet browsing and spreadsheets. However, it does not cover advanced features; there are shortcomings in multimedia and presentations and also in creating learning environments which include ICT. The fields of DC in PE teachers have already been analysed (Ferreres, 2011), while other authors (García-González & Sánchez-Moreno, 2014; Prat & Camerino, 2012; Úbeda-Colomer & Molina, 2016) suggest possible tools or applications (apps) for working on content specific to this area. Previous research used the classifications that best fitted their study objectives to establish the scientific foundations for knowledge of ICT and DC in teaching.

Moreover, Díaz (2015) demonstrated that teachers have advanced skills in office automation tools (word processing and presentations) and are familiar with and use classroom management and control tools and information-sourcing tools (edublogs, databases or e-journals). Likewise, Fernández-Espínola and Ladrón-de-Guevara (2015) demonstrated that PE teachers are conversant with ICT (Word, Excel, PowerPoint, email and search engines) and they think that including these technologies in PE classes has positive outcomes. Nevertheless, only a minority of them use these tools to teach their subject and moreover do so without changing their traditional roles, thus replacing textbooks without contributing anything new. Another study performed by Prat et al. (2013) showed that teachers rated their level of DC skills as intermediate-user, with knowledge of basic software, noting their (somewhat lower) knowledge of multimedia software and working in virtual teaching environments. Despite these results, it appears that in the cases in which teaching staff use ICT (social media, blogs and wikis), they do so only passively, for example as readers of information, but not actively as contributors to the development of this information.

As can be seen, previous papers look at teachers' DC but not about their knowledge of specific educational applications. Hitherto, not a great deal of work has been done on classifying ICT by content and type of activity (García-González & Sánchez-Moreno, 2014; Díaz, 2015). Although some of the efforts made by researchers have focused on ascertaining teachers' DC, the applications used for each activity and what they are used for now needs to be studied. This is especially so in view of the accelerated rate of change in the tools or applications available on the market, as it would make it possible to classify these educational uses in teaching terms. This paper seeks to evaluate the use of applications by future PE teachers (final-year students and future graduates) and based on the results help practising teachers to select the best applications for their lessons.

Methodology

Participants

The sample was comprised of 155 participants, 94 men and 61 women, 61 of whom were students on the Secondary Education University Teaching Master and 94 students doing the Physical Education speciality in Teacher Training at the University of Valencia during the 2019-2020 academic year. The students' ages ranged from 18 to 24 years (78.7%), 25 to 35 years (20.6%) and 36 to 45 years (0.6%). The non-probability convenience sampling technique, commonly used in research experiences in educational contexts (McMillan & Schumacher, 2001), was used to recruit the sample. Continuing in the line of previous research, the participants were told about the study and signed the informed consent form for the collection of information, thereby fulfilling the requirements of objectivity, impartiality and confidentiality (Díaz, 2015). They were also told that their participation in the surveys was voluntary and of their right to withdraw whenever they wanted.

Procedure

The questionnaire was designed by an expert panel based on the Delphi Method (Otero et al., 2012) used extensively in PE (Otero et al., 2012). It is a procedure that pursues consensus and qualitative agreement to achieve the consistency and validation of an instrument (Paixao et al., 2019; Escobar-Pérez & Cuervo-Martínez, 2008; Simón et al., 2017). For this purpose, and following Loevinger (1957), discriminative elaboration performed by experts was used and the first draft was modified based on the ensuing comments: a) answer options were reduced to three by means of discriminant analysis, and b) the number of questions in the "content creation" section was reduced. An expert group was subsequently consulted, following the guidelines proposed by Díaz (2015) and Ferreres (2011), by means of an online questionnaire with Likert-type answers ranging from 1 (strongly agree) to 4 (strongly disagree) and dealing with formal aspects of the questions, a general assessment of the questionnaire or functional aspects and with an open-ended question for adding or suggesting changes. The majority of the experts (85%) awarded a score of 4 (strongly agree) to all the items. The instrument's reliability was determined by test-retest with Cohen's kappa (κ) and Kendall Tau-b (τb) (Escobar-Pérez & Cuervo-Martínez, 2008) statistics following the analysis of the results obtained by a participant who completed the questionnaire for a second time after an interval of 14 days (Díaz, 2015). In this respect, total agreement and optimal values were found ($\kappa = 1$; $\tau b = 1$). Cronbach's α (consistency) and Intraclass Correlation Coefficient (ICC) were .96 and .52, respectively, for this questionnaire, making it possible to gauge the validity of the content and reliability of the CUTDEF (Questionnaire on the Knowledge and Use of ICT by PE Teachers) created by Menescardi et al. (2019.

Instruments

A quantitative methodology was used by means of a survey and questionnaire (Ruiz-Bueno, 2009). The previously validated CUTDEF questionnaire (Menescardi et al., 2019) was devised to perform the study.

The questionnaire consisted of two sections: a) personal and professional contextual information and b) the use of educational applications. The first section studies the respondents' characteristics, whereas the second included a DC model developed on the basis of a number of sources (Díaz, 2015; Ferreres, 2011; García-González & Sánchez-Moreno, 2014; INTEF, 2017; Suárez-Rodríguez et al., 2012). This second section was structured in the areas shown in Table 1.

Data analysis

SPSS v.22 software was used for the descriptive statistics (frequency and percentage) on the use of the applications included.

Results

Results in the use of applications related to access to and management of information

The results in the use of this type of applications are displayed in Table 2. Particular mention should be made of the use of Google Chrome as a browser (88.39%) and as a search engine (98.71%), as well as of YouTube as an information-sourcing repository. However, little use is made of applications for class and teaching work management (82.58%).

Results in the use of communication and collaboration applications

With regard to the use of these tools (Table 3), Gmail is the main email manager used (95.48%), Drive is used for online file management (94.19%), Instagram as a social media site (94.19%), Wikipedia as a wiki (66.45%) and Skype for video-conferencing (64.52%). Similarly, the limited use of blogs and websites (69.68%) and the failure to recognise virtual learning environments (42.58%) should be emphasised.

Table 1
Areas and tools or applications used and included in the CUTDEF.

Areas	Tools or applications
Access to and management of information	Internet browsers, information-sourcing tools, repositories, tools for class and teaching work management
Communication and collaboration	Email managers, online file management and hosting, virtual learning environments, management of websites and blogs, social media, wikis, video and web-conferences
Content creation (generic)	Word processors, spreadsheets, databases, presentations, video creation and edition, creation of collages, infographics, murals or posters, audio and voice recording and edition, augmented reality, immediate feedback questionnaires, writer portfolios and programs
Content creation (PE specific)	Knowledge of the human body, orientation, body expression, physical condition and health and motion analysis on video and sports white-boards

Source: own compilation.

Table 2
Results (frequency and percentage) of the tools or applications used for access to and management of information.

Tools or applications used		Fr.	%
For browsing the Internet	Google Chrome	137	88.39
	Internet Explorer	28	18.06
	Mozilla Firefox	56	36.13
	Others: Safari, Opera, Ecosia	17	10.97
For searching for information on the Internet	Google	153	98.71
	Yahoo	2	1.29
	Others: Google Scholar, WOS, Dialnet, EBSCO	87	56.13
As information-sourcing repositories	Eduweb	33	21.29
	TED	22	14.19
	YouTube	93	60.00
	Others: Dialnet, ERIC, WOS, G.Scholar, SportDiscus, PubMed	24	15.48
	None	22	14.19
For managing classes and teaching work	Additio	3	1.94
	Class dojo	9	5.81
	Idoceo	3	1.94
	Others: Symbaloo, TokApp	3	1.94
	None	128	82.58

Source: own compilation.

Table 3
Results (frequency and percentage) of the tools or applications used for communication and collaboration.

Tools or applications used		Fr.	%
For managing email	Gmail	148	95.48
	Hotmail-Outlook	70	45.16
	Yahoo	0	0.00
For online document and file management	Drive	146	94.19
	Dropbox	66	42.58
	iCloud	43	27.74
	Others: Mega, WeTransfer	8	5.16
	None	3	1.94
As virtual learning environments	Edmodo	11	7.10
	Google Classroom	7	4.52
	Moodle	75	48.39
	None	66	42.58
For educational web and blog management	Blogger	16	10.32
	Edublog	6	3.87
	WordPress	26	16.77
	None	108	69.68
As social media	Facebook	117	75.48
	Instagram	146	94.19
	Twitter	78	50.32
	None	6	3.87
For working with wikis	Weebly	1	0.65
	Wikipedia	103	66.45
	Wikispaces	4	2.58
	None	45	29.03
For video- or web-conferencing	Facetime	62	40.00
	Google Hangout	12	7.74
	Skype	100	64.52
	Others: WhatsApp, Discord, Team Speak 3, Duo	11	7.10
	None	41	26.45

Source: own compilation.

Table 4
Results (frequency and percentage) of the tools or applications used for content creation.

Tools or applications used		Fr.	%
As a word processor	Documents (Google)	69	44.52
	Word	148	95.48
	Open Office	15	9.68
	Other: Pages	1	0.65
	None	1	0.65
For creating spreadsheets	Calc (Open Office)	14	9.03
	Spreadsheet (Google)	25	16.13
	Excel	134	86.45
	None	14	9.03
For creating databases	Access	22	14.19
	Dbase	1	0.65
	Filemaker	1	0.65
	None	127	81.94
For producing presentations	PowerPoint	150	96.77
	Prezi	65	41.94
	Presentations (Google)	36	23.23
	Others: Keynote, Genially	2	1.29
	Gimp	15	9.68
For image creation and edition	Paint	150	96.77
	Photoshop	65	41.94
	Others: Picasa, Picsart, VSCO, HUJI, Instasize, Lightroom, PicsArts, PixelMator, Snapseed, Pixlr Express	36	23.23
	None	2	1.29
For video creation and edition	Imovie	15	9.68
	MovieMaker	77	49.68
	WeVideo	60	38.71
	Others: Filmora, Adobe, Quik, Sony Vegas, VideoPad	12	7.74
	None	41	26.45
For creating collages, infographics, murals or posters	Mural.ly	32	20.65
	PowerPoint	66	42.58
	Padlet	3	1.94
	Others: Canva, Adobe Photoshop, PicsArts, Pixlr Express, Picktochart	14	9.03
	None	34	21.94

Source: own compilation.

Table 4 *(Continuation)*
Results (frequency and percentage) of the tools or applications used for content creation.

Tools or applications used		Fr.	%
For sound and voice recording and edition	Audacity	23	14.84
	Voice Notes	115	74.19
	VLC	37	23.87
	Others: Lenso create, Virtual DJ	2	1.29
	None	24	15.48
Augmented reality	Unity 3D	3	1.9
	None	152	98.1
For producing immediate feedback questionnaires	Edpuzzle	3	1.94
	Plickers	33	21.29
	Kahoot	102	65.81
	Others: Google Docs, Google Surveys, Socrative	6	3.87
	None	48	30.97
For creating portfolios	Weebly	1	0.65
	Google Sites	11	7.10
	Pathbrite	0	0.00
	Others: Word	1	0.65
	None	142	91.61
For creating activities	Cuadernia	3	1.94
	Jclic	6	3.87
	HotPotatoes	1	0.65
	None	145	93.55

Source: own compilation.

Results in the use of applications for content creation

Table 4 illustrates the use of this type of tools, with Word (95.48%), Excel (86.45%) and PowerPoint (96.77%) as the programs most used for creating documents, spreadsheets and presentations, respectively. PowerPoint is also used to produce collages, infographics, murals and posters (62.58%). The use of Paint is also particularly relevant (49.68%) for image creation and MovieMaker (42.58%) for videos, as well as Voice Notes (74.19%) and Kahoot for producing immediate feedback questionnaires (65.81%). The use of augmented reality applications (98.10%), portfolios (91.61%), author programs for creating activities (93.55%) and databases (81.94%) was observed.

Results in the use of applications for the creation of PE-specific content

This type of application is barely used (Table 5), since a large percentage of the respondents said that they did not use them for knowledge of the human body (89.68%), body expression work (92.90%), and motion analysis (86.45%). The majority of the students only claimed that they were familiar with and use applications for orientation work, the best-known one being Google Maps (72.90%).

Table 5
Results (frequency and percentage) of the specific tools or applications used for PE content creation work.

Tools or applications used		Fr.	%
For knowledge of the human body	Skeleton 3	4	2.58
	Imuscle 2	2	1.29
	Jump it	6	3.87
	Others: Human Anatomy Atlas, muscle and motion, my jump, powerlift app, lifesum, aceworkout, anatomylearning.com	6	3.87
	None	139	89.68
For orientation work	Brújula [Compass]	30	19.35
	Google Maps	113	72.90
	Wikiloc Outdoor Navigation GPS	11	7.10
	Others: Geocaching, IOs Maps	3	1.94
	None	30	19.35
For body expression and rhythm work	Pro Metronome	2	1.29
	Balance it	8	5.16
	Drama Games	1	0.65
	None	144	92.90
For physical condition and health work	Fitbit	21	13.55
	Runtastic	47	30.32
	Edufit	2	1.29
	Others: Smart Watch, Endomondo, Strava, Garmin, Mi Fit, Polar, Ergdata, myjump	18	11.61
	None	80	51.61
For motion analysis in video and sports whiteboards	Coach Board	7	4.52
	Coach Eye	4	2.58
	Coachmvideo	0	0.00
	Others: Kinovea, Longo match, Hudl Technique, Jes-soft.com, video delay	10	6.45
	None	134	86.45

Source: own compilation.

Discussion

Hitherto, previous papers have addressed teachers' DC but not their knowledge of specific educational applications, and so research is called for in order to ascertain their actual use. For this purpose, the objective of this study was to evaluate the use of applications by future PE teachers (final-year students and future graduates) to identify their level of DC and to examine, on the basis of their role as trainers, what needs to be done in order for them to have greater DC and knowledge of the use of tools focusing on PE lessons.

As for applications related to access to and management of information, the results showed, in line with previous research (Pathak et al., 2012), that the applications used to browse the Internet are provided by Google (Google Chrome, 88.39%, and the Google search engine, 98.71%, respectively). Moreover, the most commonly used repository

(digital content storage platform) was YouTube (60%), in line with the findings of DeWitt et al. (2013), in view of its capacity to provide information. The use of search engines, Internet news, databases or e-journals by PE teachers has increased in recent years, eating away at the use of books or hardcopy journals for these tasks (Woods et al., 2008), so teaching staff need to be expert users of these search applications. By contrast, the scant use of applications for the management of classes and teaching work (82.58%) is striking, as was demonstrated by Díaz (2015). Although a certain amount of time has elapsed since the publication of the previous papers (DeWitt et al., 2013; Díaz, 2015), no improvements in DC in the use of these applications by teachers were apparent. Generally speaking, the group studied may be characterised as "standard Google users". It should be emphasised that ICT allow administrative and management tasks to be performed faster (Cabero & Llorente, 2008), so this type of applications could make for greater efficiency and also increase students' actual motor activity time, normally short in PE lessons and which teachers sometimes use to take the register or for class management (López-Taveras & Moya-Mata, 2019). In this regard, the literature suggests that teachers should be conversant with and use applications such as ClassDojo or iDoceo (García-González & Sánchez-Moreno, 2014).

Collaboration and communication tools enable social interaction and dialogue among colleagues, expert personnel and teaching staff (DeWitt et al., 2013) and may range from emails, forums, chats and blogs to collaborative wikis. The most commonly used email and document managers are the options provided by Google (Gmail, 95.48%, and Drive, 94.19%) because they are free, deliver substantial sending and storage capacity (Gb) and are also compatible with Google Apps (Rodríguez et al., 2013). These applications make it possible to share and store information and are compatible with the collaborative creation of documents or other files, thus adapting teaching to the Information and Knowledge Society.

With regard to virtual learning environments (VLE), the results showed that the most used platform is Moodle, which is the one used at the university. Although students are familiar with the VLE that they use, all schools should have a VLE since it delivers a broad range of resources and facilities that can be leveraged by teachers and students alike (Prat et al., 2013). In this regard, some schools have their own educational platforms (Google Classroom) which allow networking, resource-sharing, the design of new virtual venues and connection with other professionals, fostering innovation in teaching practices and ultimately improving teaching and learning processes (Calero, 2019).

In turn, most of the respondents said that they do not use applications for work such as blogs and websites, whereas those who do opt for Blogger and WordPress which can be utilised to source ideas on how other experts (PE teachers) employ activities and proposals in their lessons (DeWitt et al., 2013) or include them in the subject in order to reflect on the performance of physical activity and sports (Úbeda-Colomer & Molina, 2016). As for working on social media, and in line with DeWitt et al. (2013), the most used sites are Facebook (75.48%) and Instagram (94.19%), which allow followers to comment upon their likes and on publications and also share documents, photos and videos. It was found that although university students make extensive use of social media in their daily life, teaching use of social media is limited. Likewise, wikis are hardly used (Wikipedia: 29.03%) and there is poor diversity of video- and web-conferencing applications (Skype: 64.52%). Better use of social media would be a teaching innovation in PE in order to encourage students to participate in out-of-school sports activities (Prat et al., 2013), enabling the collaborative creation of information on websites and curricular materials (Colas-Bravo et al., 2018), thus turning ICT into LCT and encouraging students to learn with technology (Prat et al., 2013). Therefore, it is evident that future teachers are still not leveraging the possibilities of these applications and only use them conventionally.

As far as content creation applications are concerned, previous studies have shown that teachers have a mastery of office automation tools (word processing, spreadsheets and presentations) as well as audio and video edition and creation tools, yet as noted above lack a similar skill level in the use of collaboration and communication tools (Díaz, 2015; Fernández-Espínola & Ladrón-de-Guevara, 2015; Prat et al., 2013). This trend is maintained in this paper, which points to frequent use of Microsoft Office tools (Word: 95.48%; Excel: 86.45% and PowerPoint: 96.77%), perhaps because they are older, although the use of Google Apps is on the increase as they are more economical and can be used without having to download applications onto a computer (Joyanes, 2009). Nevertheless, most teachers are skilled in creating and editing audio and videos (Díaz, 2015) with MovieMaker (42.58%) and Voice Notes (74.19%). Despite this, for the moment there is still little creation of learning environments with ICT, which could account for the fact that most of the participants use PowerPoint to create collages, murals, infographics and posters and are not familiar with other applications such as Padlet, Canva or Mural.ly, etc. Similarly, competence in content creation with augmented reality, writer programs, portfolios, etc. is still poor and the failure of most participants to use these applications is patent.

As can be seen from this paper, the lack of familiarity with specific applications forces future teachers to use more generic ones (Suárez-Guerrero et al., 2016), and it

is clear that a great deal remains to be done for ICT to be integrated in classrooms.

Finally, with regard to applications and tools (apps) for PE content work, the failure to use these applications and tools for knowledge of the human body and psychomotricity and body expression along with motion analysis in video and sports whiteboards is particularly significant. To a lesser extent they are familiar with and use applications for working with orientation and geolocation content as reported by DeWitt et al. (2013), particularly Google Maps, whereas almost half of the participants mentioned the use of physical fitness and health applications (Runtastic, Fitbit). These findings contradict the results of the studies by Woods et al. (2008), which indicate that PE teachers have a developed DC when it comes to using tools for teaching and PE and sports performance management (the use of pedometers, physical performance monitoring devices, etc.), and it is concluded that they use these devices for personal use but not for teaching purposes. With respect to this result, and as Prat and Camerino (2012) show, the introduction of LCT into PE is still very recent and often seen not only as a challenge but also as a threat to the already scarce time available in PE lessons (Corrales, 2009). However, when people understand that using LCT can complement and even broaden knowledge and learning in this area, these tools can be integrated easily. Here applications such as Wikilog (Blanco et al., 2016) and Geocaching (Teles da Mota & Pickering, 2020) have proven their usefulness as a complement to orientation activities in the environment activity block.

Similarly, the use of watches and activity bracelets is becoming increasingly more common for monitoring physical activity time and intensity (Rosenberger et al., 2019), which could be appealing not only for their use in PE classes but also for students to begin using them in their leisure time and thus increase their daily physical activity. It would also be a good idea to consider the introduction of active video games (Cuberos et al., 2016), which besides making physical fitness work easier also provide access to artistic and expressive content through well-known games such as *Just Dance*.

One of the limitations of this paper is that the educational use of these applications by teachers or whether they are used for personal purposes was not taken into consideration, meaning that future research could continue to investigate PE teachers' knowledge or awareness and use of such applications. Despite this limitation, this is one of the first papers to address the knowledge of certain educational and PE-specific applications used by future PE teachers. It is also significant in that it studies a population which hitherto has attracted scant attention in technology-related research, i.e. trainee PE teachers, and because it deals with a topic, namely the use of technology, which is normally assumed or taken for granted in DC research. Therefore, the results of this paper could constitute a preliminary stage for future studies about DC.

Conclusions

The results of the study led to the following conclusions: Irrespective of the type of application (access to and management of information, collaboration and communication or content creation), a greater use of Google applications (Gmail, Drive) was found because they are free and compatible with Google Apps, the Office suite tools (Word, Excel and PowerPoint) as well as YouTube and social media sites (Facebook and Instagram).

By contrast, the use of applications for class management and teaching work and the creation of audiovisual material (video and audio) is minimal. Therefore, it may be concluded that teachers use few applications, and the ones that they do use are general and fail to straddle all the possibilities of use and the potentialities offered by the tools available on the market. For this reason, future and current teachers should think about the way ICT are being used in education, putting to one side prejudices and the insecurity involved in using them in the classroom. They should be trained in this area and should transition from a traditional teaching model to a model that embraces active methodologies using ICT.

To this end, teaching staff need to be conversant with these applications (ICT) and how to plan learning environments and build learning communities (LCT) until ICT are fully integrated at the institutional level (EPT, Empowerment and Participation Technologies) (Ferreres, 2011). Ultimately, a great deal remains to be done in this area and in the use and integration of ICT in classrooms at all educational levels.

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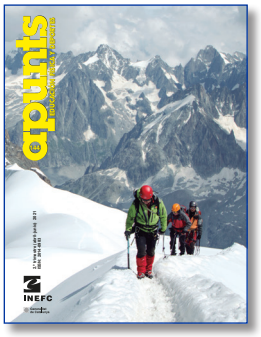

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Motivational Teaching Style in Physical Education: How does it affect students' experiences?

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Abstract

Following self-determination theory, the objective of this study was to analyse whether pupils' perception of support to basic psychological needs (autonomy, competence and relatedness) and teachers' controlling style (internal and external) predict pupils' experience in physical education classes. A total of 942 Compulsory Secondary Education (CSE – aged 12 to 16) and *Bachillerato* (post-16 pre-Uni stage) students participated (M = 14.37; SD = 1.55; 50.3% girls and 49.7% boys). The results showed that support to relatedness was a positive predictor of pupil experiences, whereas the internal controlling style was a negative predictor. Pupils who experienced "very bad" and "bad" experiences presented the lowest values of perception of support to basic psychological needs and the highest internal and external controlling style values, whereas the opposite occurred in pupils who reported "very good" experiences. These findings underline that it is important that physical education teachers use a motivational style which supports the three basic psychological needs and that they avoid using a controlling style in order to generate more positive experiences in their pupils.

Keywords: basic psychological needs, controlling style, secondary education, self-determination theory, teaching style

Introduction

Regularly performing physical activity (PA) has multiple benefits for young people's health. However, most adolescents do not fulfil the recommendations of doing moderate-to-vigorous intensity PA (at least 60 minutes a day in children and adolescents aged between 5 and 17 years, WHO, 2010). For example, a recent study conducted in 146 countries showed that 81% of young people aged between and 11 and 17 years did not fulfil these international recommendations (Guthold et al., 2020). Among the factors that influence the performance of PA, a number of studies have shown that positive pupil experiences (enjoyment, learning, predisposition, etc.) in physical education (PE) classes may help to improve their intention to be more active outside the classroom. By contrast, negative experiences (boredom, incompetence, frustration, etc.) in this context may lead them to give up doing physical activity and sports (Beltrán-Carrillo et al., 2012; White et al., 2020). Therefore, in their motivational style PE teachers may prove to be a fundamental part in triggering positive experiences in pupils in PE classes (Vasconcellos et al., 2019). These experiences could have an indirect impact on the increase in PA levels inside and outside the PE class (Hollis et al., 2017; Slingerland and Borghouts, 2011).

On this point, self-determination theory (SDT) (Deci & Ryan, 1985), one of the most deeply-rooted theoretical frameworks in the educational setting in explaining human behaviour, posits that there are three basic psychological needs (BPN): autonomy, competence and relatedness, which are indispensable in improving pupil motivation and consequently the development of positive consequences in PE classes (Ryan & Deci, 2017). In the educational setting, pupils satisfy their autonomy when they feel that they themselves are the source of their actions, their competence when they feel that they are effective in the proposed activities and relatedness when they feel part of the group (Ryan & Deci, 2017). According to SDT, PE teachers through a motivational teaching style based on supporting the three BPN may bring an influence to bear upon the satisfaction of these needs (Vasconcellos et al., 2019) since they can support their pupils' autonomy when they allow them to take decisions in the teaching and learning process. In the same way, they can support their competence by using interactive feedback which enables them to identify the rules of action of the proposed motor situations. Finally, they can support relatedness when they build an atmosphere that is conducive to promoting pupils' positive interaction and integration. In this respect, a number of studies have demonstrated that support by the teacher to the three BPN can trigger increased satisfaction and a broad range of positive consequences in their pupils (enjoyment, learning, the intention to be active, etc.) (Pérez-González et al., 2019; Valero-Valenzuela et al., 2020; Vasconcellos et al., 2019).

However, learners' BPN can also be frustrated in PE classes. For example, their autonomy may be frustrated when they perceive pressure and alienation in the exercises they do. Their need for competence may also be frustrated when they have a feeling of inferiority and failure in successfully performing tasks. Finally, students who feel rejected by or barely integrated with their classmates might perceive that their need for relatedness is frustrated (Ryan & Deci, 2017). The use of a controlling style by PE teachers is positively related to the frustration of these three BPN in pupils (Vasconcellos et al., 2019). According to some authors (Burgueño et al., 2021; De Meyer et al., 2016; Soenens & Vansteenkiste, 2010), PE teachers' controlling style may take two different forms: internal and external. The former refers to the behaviours and attitudes of teachers who seek to trigger feelings of anxiety, shame or embarrassment and blame in pupils (Soenens & Vansteenkiste, 2010). It should be emphasised that these attitudes are usually not very visible, meaning that they are difficult to identify (Soenens et al., 2012). For example, some internal control strategies used by teachers might be related to somewhat unaffectionate non-verbal language such as apathetic looks, gestures of disappointment or ignoring pupils during exercises (Burgueño et al., 2021; De Meyer et al., 2016). Moreover, the internal controlling style can also be made apparent to the entire group through the verbal expression, for instance, of disappointment with the behaviour of a class (Burgueño et al., 2021; De Meyer et al., 2016). Unlike internal control, external control involves external contingencies (Burgueño et al., 2021; De Meyer et al., 2016). For example, some external control strategies might be the use of punishment, threats of giving students bad marks, doing more boring activities or simply yelling at pupils and scolding them for their behaviour (Burgueño et al., 2021; De Meyer et al., 2016). Contrary to the motivational teaching style of support to BPN, the controlling style has been positively associated with frustration of BPN and, in turn, with various negative consequences and experiences in PE classes (boredom, fear of making mistakes, etc.) (Bartholomew et al., 2018; Behzadnia et al., 2018; Burgueño et al., 2021).

Hence the motivational teaching style, consisting of a degree of support to BPN and the use of a controlling style, may shape pupils' experiences in PE classes, experiences which may be essential in their embracing a more active lifestyle (Behzadnia et al., 2018). However, while PE teachers' style of support to BPN has been analysed in depth, by comparison their controlling style has attracted far less attention (Vasconcellos et al., 2019). Moreover, according to the authors there are only two studies about PE

classes that examine the influence of these teachers' internal and external controlling style (Burgueño et al., 2021; De Meyer et al., 2016) on pupil motivation variables. In the two studies both the internal and the external controlling styles were negatively related to the satisfaction of BPN (Burgueño et al., 2021) and autonomous motivation (De Meyer et al., 2016) and positively to the frustration of BPN (Burgueño et al., 2021) and to controlled motivation and lack of motivation (De Meyer et al., 2016). The predictive analyses showed how the internal controlling style was a predictor of less adaptive motivational processes (Burgueño et al., 2021; De Meyer et al., 2016). Similarly, there is a very limited number of studies that have examined pupils' perception of their experiences in PE classes (Gutiérrez, 2014) and none have examined the relationship with the motivational teaching style (Vasconcellos et al., 2019). Therefore, the objectives of the study were: 1) to analyse whether support to the three BPN and the use of a controlling style by PE teachers predict negative or positive experiences among pupils, and 2) to examine the type of experiences perceived by pupils in PE classes depending on the level of support to the three BPN and on the use of a controlling style by PE teachers.

Methodology

Design and participants

A descriptive cross-sectional study was performed in which by means of intentional sampling a total of 942 CSE and *Bachillerato* students from five out of eight secondary schools in Huesca participated. The participants were aged between 12 and 17 years ($MA = 14.37$; $SD = 1.55$; 50.3% girls and 49.7% boys) and were distributed as follows in the school academic years: 1st CSE = 195; 2nd CSE = 155; 3rd CSE = 160; 4th CSE = 177; 1st *Bachillerato* = 255. The Research Ethics Committee of the Region of Aragon (CEICA) approved the study (PI1570283).

Variables and instruments

Support to BPN by PE teachers

The Questionnaire of Basic Psychological Needs Support (QBPNS; Sánchez-Oliva et al., 2013) was used to measure pupils' perception of PE teachers' support to the three BPN. This instrument, which begins with the statement "In PE classes, our teacher…", is comprised of 12 items grouped into three factors (four items per factor) which measure support to autonomy ("he/she often asks us about our preferences regarding the activities to be done"); support to competence ("he/she proposes activities suited to our level so that we will do them well"), and support to relatedness ("he/she fosters a good atmosphere among classmates"). The response format used was a Likert 1-5 scale, where 1 was "totally not agree" and 5 was "totally agree".

PE teachers' internal and external controlling style

The students' perception of their PE teachers' internal and external control behaviours was evaluated by means of the Spanish version (Burgueño et al., 2021) of the Psychologically Controlling Teaching Scale (De Meyer et al., 2016; Soenens et al., 2012). This instrument, which begins with the statement "My PE teacher…", is comprised of two factors that measure the internal controlling style (four items; "Pays less attention to me when I disappoint him/her") and the external controlling style (four items; "Yells when I am not doing what (s)he wants"). The response format used was a Likert 1-5 scale, where 1 was "totally not agree" and 5 was "totally agree".

Pupils' experiences in PE classes

In line with previous research (Gutiérrez, 2014), the following question was used to evaluate pupils' experiences in PE classes: What are your experiences in the PE subject like? The possible answers were: (1) "Very bad", (2) "Bad", (3) "Average", (4) Good" and (5) "Very good".

Procedure

Before starting the study, the lead researcher contacted the schools' administration and PE teachers to inform them about the objectives and secure their collaboration. The families or legal guardians were subsequently asked to provide the informed consent for their children to participate voluntarily in the research. Several days were needed to administer the questionnaires at the schools in view of the large sample size. The questionnaires were completed on paper in approximately 15 minutes in a classroom with a calm atmosphere and an appropriate temperature. The lead researcher was on hand throughout the administration process to deal with possible queries and insisted upon the anonymity of the answers and that the respondents should

reply as honestly as possible. The PE teachers were not present while the pupils completed the questionnaires so as not to distort their answers.

Data analysis

First of all, the descriptive statistics (mean and standard deviation) were calculated along with reliability (Cronbach's α), and a bivariate correlation analysis of all the variables involved in the study was performed. Secondly, a stepwise linear analysis was conducted to identify whether the degree of support to the three BPN (autonomy, competence and relatedness) and controlling style (internal and external) were predictive of pupil experiences in PE classes. Finally, a bivariate analysis of variance (ANOVA) was carried out by means of Bonferroni's correction to assess the pupils' perception of the degree of support to BPN and the controlling style used by the PE teachers according to pupils' experiences in the PE classes. The level of statistical significance was set at $p<.05$. Effect sizes (η_p^2) of .01 were regarded as low, above .06 as moderate and above .14 as high (Cohen, 1988). All the analyses were performed using SPSS 23.0 software.

Results

The descriptive statistics (*M* and *SD*), Cronbach's α coefficients and bivariate correlations of all the study variables are shown in Table 1. Generally speaking, the pupils perceived higher mean scores in support to autonomy, support to competence and particularly in support to relatedness than in their PE teachers' internal and external controlling style. Moreover, support to autonomy, competence and more particularly to relatedness correlated significantly and positively with the pupils' experience in the PE classes, whereas the external controlling style and more particularly the internal controlling style were negatively correlated.

To address the first study objective, the pupils' experiences in PE were input into the linear regression analysis as a dependent variable. The three supports to BPN along with the internal and external controlling styles were entered separately as independent variables. Whereas support to autonomy and competence did not significantly predict pupils' experiences in PE classes, support to relatedness did predict them positively $\beta=.24$ $p<.01$) with an explained variance of 5%. Conversely, the internal controlling style negatively predicted pupils' experiences in PE classes ($\beta=-.44$ $p<.01$) with an explained variance of 20%. On the other hand, the external controlling style positively predicted the students' experiences ($\beta=.09$ $p<.01$), although the explained variance for this variable was residual ($R^2=0.5\%$).

With regard to the second study objective, as shown in Table 2, the ANOVA performed between the different pupil-reported PE experiences ("very bad", "bad", "average", "good" and "very good") and pupil-perceived PE teachers' motivational style (support to autonomy, support to competence, support to relatedness, internal controlling style and external controlling style) were significant ($p<.001$), presenting effect sizes ranging from moderate to high. The students who had "very bad" and "bad" experiences in PE presented significantly lower values in support to the three BPN as well as significantly higher values in internal and external controlling style compared to the other students who had "very good", "good" or "average" experiences.

Table 1
Descriptive analyses and correlations between the study variables.

Variables	α	*M*	*SD*	1	2	3	4	5	6
1. Support to autonomy	.81	3.22	1.12	-	.69**	.67**	-.36**	-.38**	.31**
2. Support to competence	.82	3.60	1.10		-	.72**	-.43**	-.43**	.33**
3. Support to relatedness	.88	3.78	1.14			-	-.47**	-.47**	.40**
4. Internal controlling style	.91	2.00	1.05				-	.88**	-.44**
5. External controlling style	.80	1.95	1.00					-	-.37**
6. Experiences in PE	-	4.18	0.80						-

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

At the opposite extreme, students who reported "very good" experiences perceived significantly higher values in terms of support to the three BPN and significantly lower values in terms of internal and external controlling style compared to the students who had "good", "average", "bad" and "very bad" experiences. Moreover, the students who reported "good" experiences were significantly different from the students with "average" experiences, presenting higher values of support to the three BPN and lower internal and external controlling style values.

Table 2
Pupil-perceived experiences in PE classes depending on support to BPN and the use of a controlling style by the PE teachers.

Variables	Pupils' experiences in PE classes					F	*p*	η_p^2
	Very bad	Bad	Average	Good	Very good			
	M (SE)	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*			
Support to autonomy	1.25[a] (.37)	1.58[a] (.24)	2.74[b] (.09)	3.25[c] (.05)	3.47[d] (.05)	29.51	<.001	.112
Support to competence	1.84[a] (.36)	1.80[a] (.24)	3.14[b] (.09)	3.58[c] (.04)	3.89[d] (.05)	33.41	<.001	.125
Support to relatedness	1.31[a] (.36)	1.68[a] (.24)	3.18[b] (.09)	3.79[c] (.05)	4.15[d] (.05)	51.03	<.001	.179
Internal controlling style	4.68[a] (.38)	3.76[a] (.25)	2.69[b] (.09)	1.99[c] (.05)	1.62[d] (.05)	64.01	<.001	.215
External controlling style	4.22[a] (.33)	3.30[a] (.22)	2.27[b] (.08)	1.88[c] (.04)	1.71[d] (.05)	23.11	<.001	.090

Note. SE = Standard error. The superscript letters (a, b, c, and d) represent significant differences in motivational teaching style between the different types of experiences in PE.

Discussion

Since most adolescents do not fulfil PA recommendations (Guthold et al., 2020), the motivational style adopted by PE teachers is a key factor in getting pupils to embrace a more active lifestyle. Although the relationship between support to BPN by PE teachers and certain affective, cognitive and behavioural consequences is well-known (Vasconcellos et al., 2019), no previous studies have examined the effect of the motivational style of support to BPN and internal and external control on pupils' experiences in PE classes. For this reason, and taking SDT as reference, this study adds to knowledge of this relationship.

More specifically, the primary objective of this study was to examine whether experiences in PE would be predicted by PE teachers' support to the three BPN and/or internal and external controlling style. In line with SDT (Ryan & Deci, 2017), support to relatedness positively predicted positive pupil experiences in PE classes. In the same line, a previous systematic review showed that relatedness is considered to be one of the most influential factors in pupils' positive experiences in these classes (Beni et al., 2017; White et al., 2020). These results may be accounted for by the growing influence of relationships between peers in childhood and adolescence (Sanz-Martín, 2020). In turn, these findings underscore the importance of designing welcoming and reassuring learning environments that are conducive to positive interaction in PE classes (Sparks et al., 2017). To this end, teachers should cater to students' relatedness by using various strategies (promoting flexible and heterogeneous groups, mediating in possible conflicts or allowing the formation of different groups during the class) in order to achieve more positive experiences in PE classes (Beni et al., 2017).

However, and while this study did find positive correlations between support to autonomy and support to competence and pupils' experiences in PE classes, these two factors were not significant predictors of experiences in PE. Nevertheless, the wealth of evidence based on SDT, which shows that support to autonomy and to competence are positively related to the satisfaction of BPN and consequently to autonomous motivation and various positive consequences in PE (Pérez-González et al., 2019; Vasconcellos et al., 2019), points to the importance of implementing motivational styles based on support to all three BPN.

With regard to PE teachers' controlling style and in line with SDT (Soenens et al., 2012), the internal controlling style negatively predicted pupils' experiences in PE classes. As in previous studies, these findings suggest that certain behaviours of PE teachers, such as an aloof attitude to pupils, looks of disappointment when pupils do something wrong or simply ignoring a group of students in the course of a certain task, may not only lead to reduced motivation (Burgueño et al., 2021; De Meyer et al., 2016) but also to negative pupil experiences in PE classes. Contrary to the tenets of SDT, the external controlling style positively predicted pupils' experiences in PE classes. Nevertheless, the explained variance was below 1%, meaning that this result may be interpreted as residual.

Nevertheless, it should be emphasised that in line with SDT (Soenens et al., 2012) and previous studies (Behzadnia et al., 2018; Burgueño et al., 2021; De Meyer et al., 2016), the correlation analysis did show a negative relationship between the external controlling style and pupils' experiences in PE classes. Therefore, the results of this study suggest that PE teachers should favour positive communicative exchanges in their classes. Similarly, an internal controlling style should be particularly avoided in view of the negative implications it has with regard to pupils' experiences in PE classes (Burgueño et al., 2021; De Meyer et al., 2016). Nonetheless, future studies should dedicate further attention to the role of the internal and external controlling styles in certain motivational variables and the consequences in PE classes.

The second objective set out to analyse the type of experiences perceived by pupils in PE classes depending on the level of support to the three BPN and the controlling style of PE teachers. In line with SDT (Ryan & Deci, 2017) and previous PE studies (De Meyer et al., 2016; Haerens et al., 2018), students who reported "very bad" or "bad" experiences perceived a less optimal motivational style (low values in terms of support to BPN and high values in internal and external controlling style). These results show that teachers who do not involve their students in decision-making (support to autonomy), who fail to tailor exercises to their pupils' motor level, do not provide them with positive feedback (support to competence) or do not create an atmosphere that is conducive to pupil cooperation and integration in PE classes (support to relatedness) may induce negative consequences and experiences in their PE classes (Vasconcellos et al., 2019). Similarly, PE teachers who evince an apathetic or aloof attitude towards certain pupils, paying less attention to them or even ignoring them (internal control), as well as those who use threats, punishment or who yell (external control), may generate highly negative experiences in adolescents in PE classes (De Meyer et al., 2016).

By contrast, and consistent with SDT and previous studies (Haerens et al., 2018), students who reported "very good" experiences perceived a more optimal motivational style (high values in terms of support to BPN and low internal and external controlling style values). In this regard, the results seem to suggest that as teachers implement more strategies involving support to BPN and embrace a less controlling style, both internally and externally, their pupils experience more positive and adaptive consequences and experiences in their PE classes (Vasconcellos et al., 2019). These results may be of paramount importance since having positive experiences in PE is fundamental if young people are to continue to do PA outside the classroom (Beni et al., 2017).

Conclusions

This study demonstrates the relevance of the motivational style of support to BPN (autonomy, competence and relatedness) by PE teachers for pupils to enjoy more positive experiences in class. More particularly, it stresses that it is important that PE teachers support student relatedness in order to foster more positive experiences in PE classes. Similarly, it would seem to be important for teachers not to use a controlling style in their PE classes and more particularly to avoid the internal controlling style in view of the more negative implications that this may entail in terms of pupil experiences. The findings point to the importance of including strategies to encourage support to BPN and to avoid the use of a controlling style in the initial and continuous training of PE teachers. Similarly, it would appear to be equally important for school administrators to offer training based on SDT and more specifically on the implementation of motivational strategies that can be used by teachers in the classroom. The application of these motivational strategies by teachers could contribute to pupils embracing a healthier and more active lifestyle outside PE classes.

Finally, and while the findings add to existing evidence and underline the significance of PE teachers' motivational style, it is also important to note the limitations of this paper and some possibilities moving forward should be mentioned as well.

First of all, it is a cross-sectional study, meaning that no causality can be inferred from the relationships found. Future studies should be based on a longitudinal design that will afford greater rigour to the relationship between the motivational teaching style and pupils' experiences in

PE classes. Secondly, pupils' experiences in PE classes were evaluated by means of a single item which might limit the results' external validity. Future research should evaluate this variable using other scales in order to address the concept of experiences in PE more comprehensively. Thirdly, in this study motivational style was evaluated from the pupils' standpoint. It would be interesting for future research to also consider the relationship between the motivational teaching style and pupils' experiences of PE through PE teachers' own perception of their motivational teaching style (Abós et al., 2018). Finally, this study only evaluated pupil experiences in PE classes. Evaluate how the different motivational styles of PE teachers are related to the satisfaction and frustration of NPB, with the novelty or with the variety, could be useful to expand the evidence of TAD in the context of the EF. (Vasconcellos et al., 2019).

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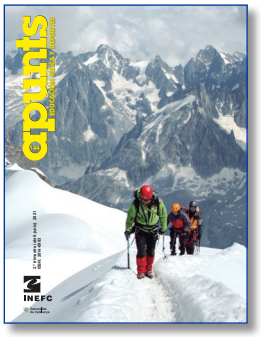

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Corner kick performance indicators in elite football

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Abstract

The aim of this study was to analyze situational and behavioral factors associated with successful corner kicks, defined as kicks that ended in a shot, in elite soccer. Within the framework of a systematic observational methodology study, we analyzed 2029 corner kicks taken by first-division (La Liga Santander) and second-division professional teams during the 2016-2017 Spanish soccer league season. A total of 229 kicks were selected that met specific conditions and ended in goal for pattern detection. The Systematic Observational Methodology (OM) was used for its analysis and he execution and outcomes of these technical-tactical set pieces were analyzed using an *ad hoc* observation instrument (SOCOP-1) that contemplates key situational and behavioral factors and was loaded into LINCE PLUS freeware program. Descriptive statistics were calculated in STATA and complemented by temporal pattern (T-pattern) analysis in THEME 6.0. The most successful kicks were those taken by a right- (or left-footed) player from the right (or left) side of the pitch and delivered to the penalty box and those taken by a right- or left-footed player from the opposite side of the pitch and delivered to the near post. Situational factors that influenced corner kick efficacy were match location (home vs away), time of the match and score when the kick was taken, and ranking of the rival team. Corner kicks should be practised under game conditions prior to matches and to train integradamente with the physical condition before to the competition.

Keywords: soccer, observation, set pieces actions (SPA), set piece, corner kick, T-patterns.

Introduction

Offensive actions in modern-day soccer can be characterized as dynamic (open play) (McGarry et al., 2002) or static, where the ball is returned to play after recovery of the ball or a stoppage (Duch et al., 2010; Maneiro et al., 2019). Set pieces, such as freekicks, throw-ins, and corner kicks, can have an impact on open play and score-lines (Wallace & Norton, 2014), and coaches are increasingly aware that their success is dependent on technical-tactical skills and physical fitness (Bush et al., 2015).

Numerous studies have examined the influence of situational and behavioral factors on performance in soccer (Carling et al., 2005; Casal et al., 2015b; Diznar et al., 2016; Kormelink & Seeverens, 1999; Maneiro, 2014; Maneiro et al., 2017; Pulling et al., 2015), and two of the most powerful indicators in this respect are goals/shots at goal and set pieces (Liu et al., 2013; 2015).

Corner kicks are important set pieces that have been analyzed both quantitatively (number of kicks awarded per match) and qualitatively (success/efficacy rates) (Ardá et al., 2014; Casal et al., 2015; Link et al., 2016; Pulling, 2015; Sainz de Baranda & López Riquelme, 2012; Silva, 2011). Considerable research has been done on behavioral factors associated with corner kicks, such as laterality of kick (Hill & Hughes, 2001), ball path and delivery area, offensive tactics such as feints and disguises (Ardá et al., 2012; Castelo, 2009), and defensive set-ups and goalkeeper position (Borras & Sainz de Baranda, 2005; Casal et al., 2015; Link et al., 2016 and Maneiro, 2014).

Situational factors have received less attention, and include home advantage (and its effects on player psychology and performance) (Carron et al., 2005; Pollard, 2006a), score-line (Bloomfield et al., 2005; Jones et al., 2004; Taylor et al., 2005), ranking or quality of the rival team (Fernández-Hermógenes et al., 2017), critical periods of play, such as the final minutes of the game when performance may be influenced by factors such as fatigue and lack of concentration (Carling et al., 2005; and Armatas et al., 2007), and tactical substitutions intended to cause disruption.

Corner kicks can have a decisive impact on the final score of matches between teams of a similar level, and some authors have stressed the importance of practising these kicks without defenders and when the players are fresh (Bonfanti & Pereni, 2002). More recently, however, there appears to be a growing tendency to work on technical-tactical aspects and physical preparation to recreate situations of physical and mental fatigue (Fernández-Hermógenes et al., 2017).

The aim of this study was to investigate the role of different situational and behavioral factors in corner kick success. A greater understanding of each of these factors and their impact on match outcomes will help coaches design strategies to improve corner kick performance in match situations.

Method

Materials

We performed a systematic observational methodology (OM) study in which we used a validated *ad hoc* instrument to systematically capture the spontaneous behavior of attacking players during the execution of corner kicks (Lozano et al., 2016; Lapresa et al., 2015). Observational methodology is a highly suitable approach for studying the dynamics of soccer (Camerino et al., 2012).

Observational design

We used a nomothetic/point/multidimensional design (N/P/M) (Anguera et al., 2011). It was nomothetic because we observed corner kicks taken by first- and second-division teams each considered a separate unit, point because each corner kick was taken at a specific time, and multidimensional because we analyzed various dimensions reflected in the multiple criteria comprising the observation instrument.

Participants

We selected a convenience sample of 20 first-division and 22 second-division teams from the 2016-2017 Spanish soccer league. Of the total 5843 corner kicks released this season and categories we observed 2029 corner kicks taken in 204 games; the kicks selected for analysis had to be succeeded and contain the following conditions: (a) defensive and offensive actions lasting at least 10 seconds, (b) five passes, or (c) a direct shot at goal.

SOCOP -1 observation instrument

To annotate the data, we used the *ad hoc* SOCOP-1 observation instrument (System for Observing Corner Kicks in Offensive Play), which was adapted from the SOFEO-1 instrument for observing strategic offensive play in soccer (Fernández-Hermógenes et al., 2017). The instrument was validated by a panel of 11 experts from the field of elite soccer, including coaches with a UEFA A license. The coding tool includes eleven criteria: 1) match location (LOC), 2) ranking of rival team (RANK), 3) match status (MS), 4) time of corner kick (T), 5) laterality of kick (LAT), 6) rival team defensive set-up (DEF), 7) ball delivery, 8) action area (AA), 9) path of ball (PATH), 10) corner kick outcome, and 11) type of shot (SHOT). The 11 criteria were expanded to create 42 exhaustive and mutually exclusive categories. These are shown in Table 1 together with their definitions. The 10-action area (AA) categories were classified according to where the kick was taken from (right or left corner).

Coding instrument

The corner kicks were analyzed in LINCE PLUS (Soto et. al., 2019), a freely available software program that simultaneously shows the following information on screen: (a) the SOCOP-1 instrument (criteria and categories), (b) the video frame being analyzed, and (c) the codes annotated by the observers (Figure 1). Each sequence analyzed started with a corner kick and ended with a goal or loss of possession/out of play. Actions after 10 seconds were not analyzed, as they were considered to form part of a different tactical strategy.

Table 1.
The SOCOP-1 observation instrument: criteria, categories, and definitions.

Criterion	Category	Description
Match location (LOC)	HOME	Home match for team being observed
	AWAY	Away match for team being observed
Ranking of rival team (RANK)	HIGH	Top four at the end of the league
	MID	Positions 5-7 at the end of the league
	MED	Positions 8-17 (first-division) or 8-19 (second-division) at the end of the league
	BOTT	Bottom three (first division) or four (second division) at the end of the league
Match status (MS)	WIN	Observed team winning
	TIE	Tie
	LOS	Observed team losing
Time of corner kick (T)	T15	Between minute 0’ and 14’59”
	T40	Between minute 15’ and 39’59”
	T45	Between minute 40’ and end of the first half
	T60	Between minute 45’ and 59’59”
	T80	Between minute 60’ and 84’59”
	T90	Between minute 85’ and end of the first half
Laterality of kick (LAK)	NATU	Natural. Right-footed player takes kick from right corner or left-footed player takes kick from left corner
	SWIT	Switched. Right-footed player takes kick from left corner or left-footed player takes kick from right corner
Rival team defensive set-up (DEF)	MAN	Man-to-man: each defender is responsible for one attacker
	ZONE	Zone: each defender is responsible for an area of the pitch
	MIX	Mixed: each defender is responsible for an area of the pitch and/or a player
Interaction context (IC)	INF1	Offensive numerical inferiority (1 player)
	INF2	Offensive numerical inferiority (≥ 2 players)
	IGU	Numerical equality (same number of attackers and defenders)

Table 1. *(Continuation)*
The SOCOP-1 observation instrument: criteria, categories, and definitions.

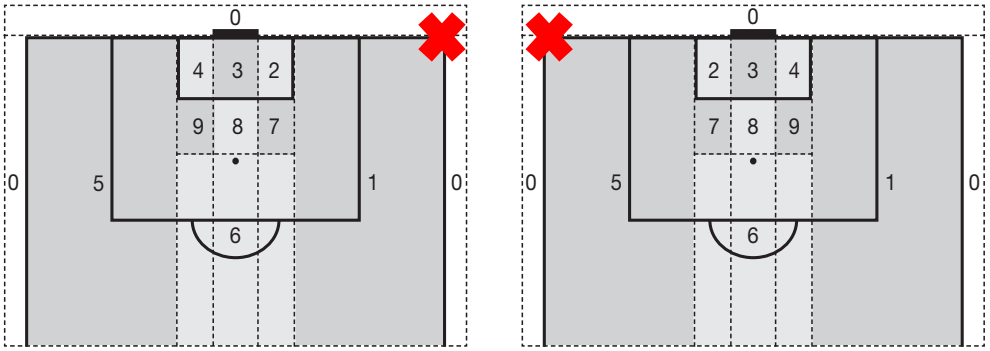
Criterion	Category	Description
Delivery of kick (DoK)	DIR	Direct: ball delivered directly to penalty area.
	IND	Indirect: ball delivered using a short pass
Action area (AA)	AA0	Goal line or side line
	AA1	
	AA2	
	AA3	
	AA4	
	AA5	
	AA6	
	AA7	
	AA8	Goal line between the posts up to height of penalty spot
	AA9	
Path of ball (PATH)	OUT	Out-swinging
	IN	In-swinging
	OTH	Other: long pass along the ground or straight path
Final action (SHOT)	NACT	No shot
	ACT	Shot
Corner kick outcome	GOAL	Kick ends in a goal
	NGW	Kick ends in a shot wide of the posts
	NGP	Kick ends in a shot between the posts but not a goal
	NGD	Kick does not end in goal and there is no chance of a goal being scored because the goalkeeper blocks the ball, the defense clears the ball from the area, a foul is committed, or the observed team takes the corner kick to maintain possession of the ball
Ending (END)	KICK	Kick
	HEAD	Header
	OTH	Other part of the body permitted by the rules

Figure 1.
Screenshot of LINCE PLUS software program at a given observation moment.

Procedure

Once the selected matches had been downloaded from the international football agency platform *Promoesport*, the observation instrument was validated by an expert panel formed by 11 highly experienced coaches. The observers responsible for coding the data were trained and the reliability of the training sets was checked by calculating Cohen's kappa statistic (Cohen, 1960) for intra- and interobserver agreement in LINCE PLUS (Soto et al., 2019). The resulting kappa statistics for all categories annotated were .95 for intraobserver agreement and .79 for interobserver agreement. The observers then analyzed and coded the full sample. The resulting codes were exported into Microsoft Excel (.xls format), for previous descriptive and into THEME (.txt format) for T-pattern analysis to search for significant patterns hidden in the data.

Statistical and T-pattern analyses

Both behavioral and situational factors were analyzed by descriptive/inferential and T-pattern analyses. The descriptive/inferential analyses of the different study behaviors were performed in Stata/IC v. 15.1 (StataCorp, College Station, TX, USA), while the T-pattern analysis was performed in THEME v.6. (Magnusson, 2000). THEME is a software package featuring algorithms that process the enormous range of combinatorial patterns underlying behaviors; it compares all behavioral patterns and retains only the most complete ones. To guarantee that any T-patterns detected were not due to random events, the following settings were used: (a) presence of a given T-pattern in at least 25% of sequences, (b) significance level of .005, and (c) redundancy reduction setting of 90% for occurrences of similar T-patterns.

Results

Univariate descriptive analysis

The absolute (*n*) and relative (%) frequencies of the categorical variables (grouped by criteria) analyzed for the 2029 corner kicks are shown in Table 2.

The results of the distribution of the 2029 corner kicks they demonstrate that more likely to be taken towards the end of the second half (minute 60-85) by a team with a home advantage or playing against a rival in the middle of the league. Defenders always outnumbered attackers and a mixed defense (combination of man-to-man and zone) was more common. Overall, 47.3% of in-swinging or out-swinging corners delivered directly to the penalty area were taken using the same foot as the side of the pitch (e.g., right-footed kick from right corner), while 52.7% were taken using a switched foot (e.g., right-footed kick from left corner). While the direct delivery of the ball to the penalty area limited the number of intervention zones, 70.9% of kicks (n = 1439) did not result in a shot at goal.

T-pattern analysis

Based on the initial results of the descriptive analysis, we conducted a T-pattern analysis of the 229 corner kicks that

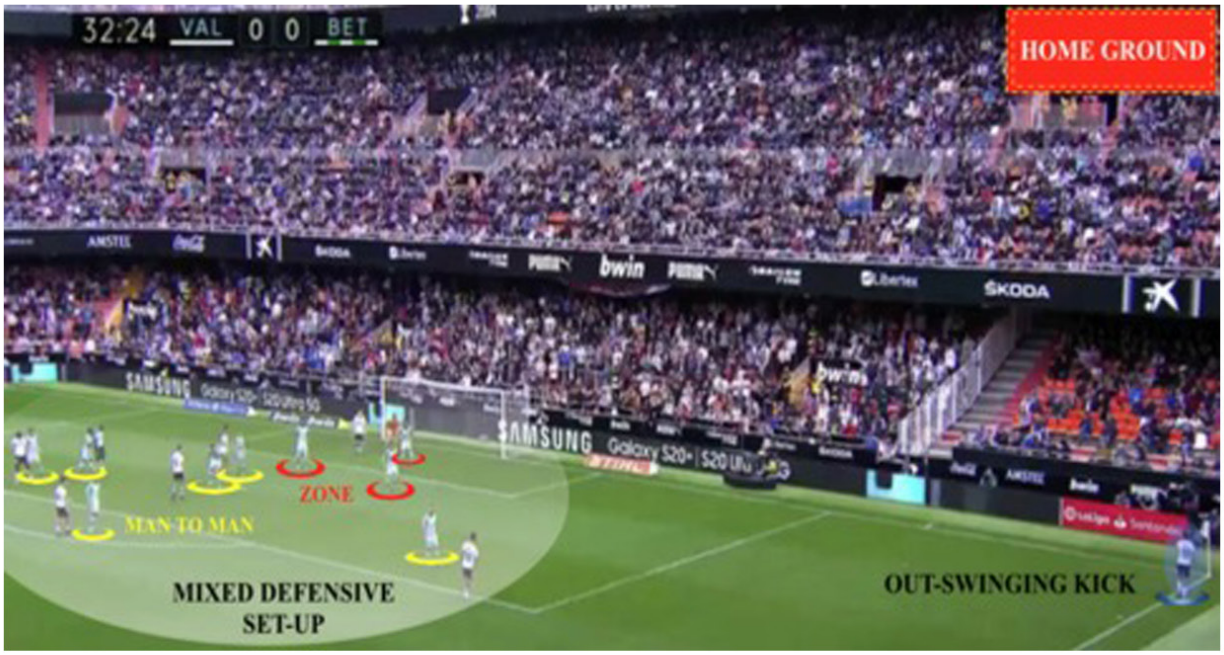
Table 2.
Descriptive analysis (absolute and relative frequencies).

Variable (code)	Category (code)	*n*	%
Match location (LOC)	Away	901	44.4
	Home	1128	55.6
Ranking of rival team (RANK)	Bottom	443	21.8
	Middle	1054	52.0
	High or top	532	26.2
Match status (MS)	Losing	625	30.8
	Tie	1001	49.3
	Winning	403	19.9
Time of corner kick (T)	Minute 0-15	307	15.1
	Minute 15-40	505	24.9
	Minute 40-45	134	6.6
	Minute 45-60	359	17.7
	Minute 60-85	522	25.7
	Minute 85-90	202	10.0
Laterality of kick (LAK)	Switched foot (0)	1070	52.7
	Natural foot (1)	959	47.3
Rival team defensive set-up (DEF)	Zone	200	9.9
	Man-to-man or mixed	1829	90.1
Interaction context (IC)	Team being observed outnumbered by two or more players	1941	95.7
	Team being observed outnumbered by one or the same number of players	88	4.3
Delivery of kick (DoK)	Indirect	320	15.8
	Direct	1709	84.2
Final action (SHOT)	No shot	1439	70.9
	Shot	590	29.1

Note: N = 2029 corner kicks in total; *n* = number of corner kicks in each category; CI, confidence interval (calculated using the Wilson method); π = proportion of sample converted to percentage; LL = lower limit; UL, upper limit.

they finished in goal, prioritizing the most relevant situational criteria in the SOCOP-1 observation instrument: match location (LOC), match status (MS), time of corner kick (T), and ranking of rival team (RANK).

This analysis detected significant behavioral patterns exhibited by attackers and defenders during the corner kick sequences analyzed. These behaviors are graphically represented in tree diagrams known as dendograms, shown in: Figures 2 match location (play at home, home groud), Figure 3 match status (tie), Figure 4 time of corner kick (between 15´-40´), and Figure 5 ranking of rival team (middle level). These diagrams show the chronological succession of the most significant offensive and defensive events for each team organized by groups of associated concurrent or sequential categories (patterns) that occur in a chronological sequence within a critical interval (time window) (Jonsson et al., 2006).



Match location

1. Corner kick taken by a player at this **home ground** using the **same foot as the side of pitch** from which the corner is taken and with a **mixed defensive set-up**.
2. **Out-swinging** kick delivered to zone 8 as the attacking players enter.
3. The action ends with a **header** that results in a **GOAL**.

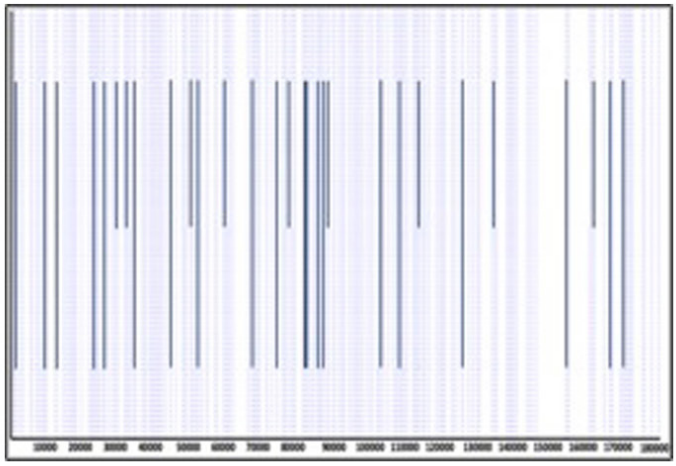


Figure 2.
Representation of the first T-Pattern found to occur in match location criteria.

Match status

1. Corner kick taken when the teams are **tied** by a player using the **same foot as the side of pitch** from which the corner is taken and with a **mixed defensive set-up**.

2. **Out-swinging** kick delivered to zone 8 as the attacking players enter.

3. The action ends with a **header** that results in a **GOAL**.

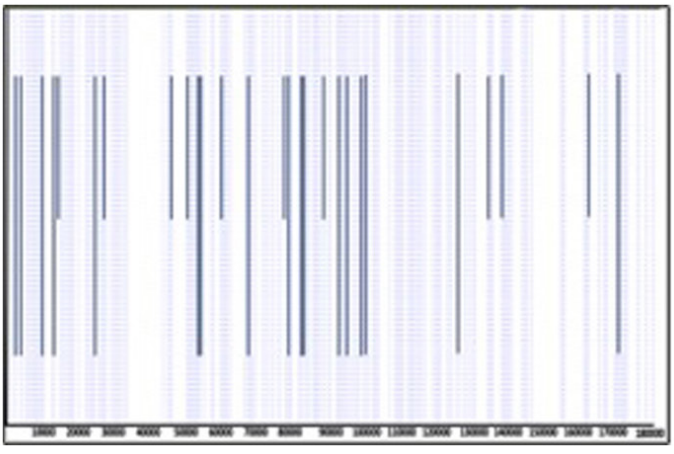


Figure 3.
Representation of the first T-Pattern found to occur in match status criteria.

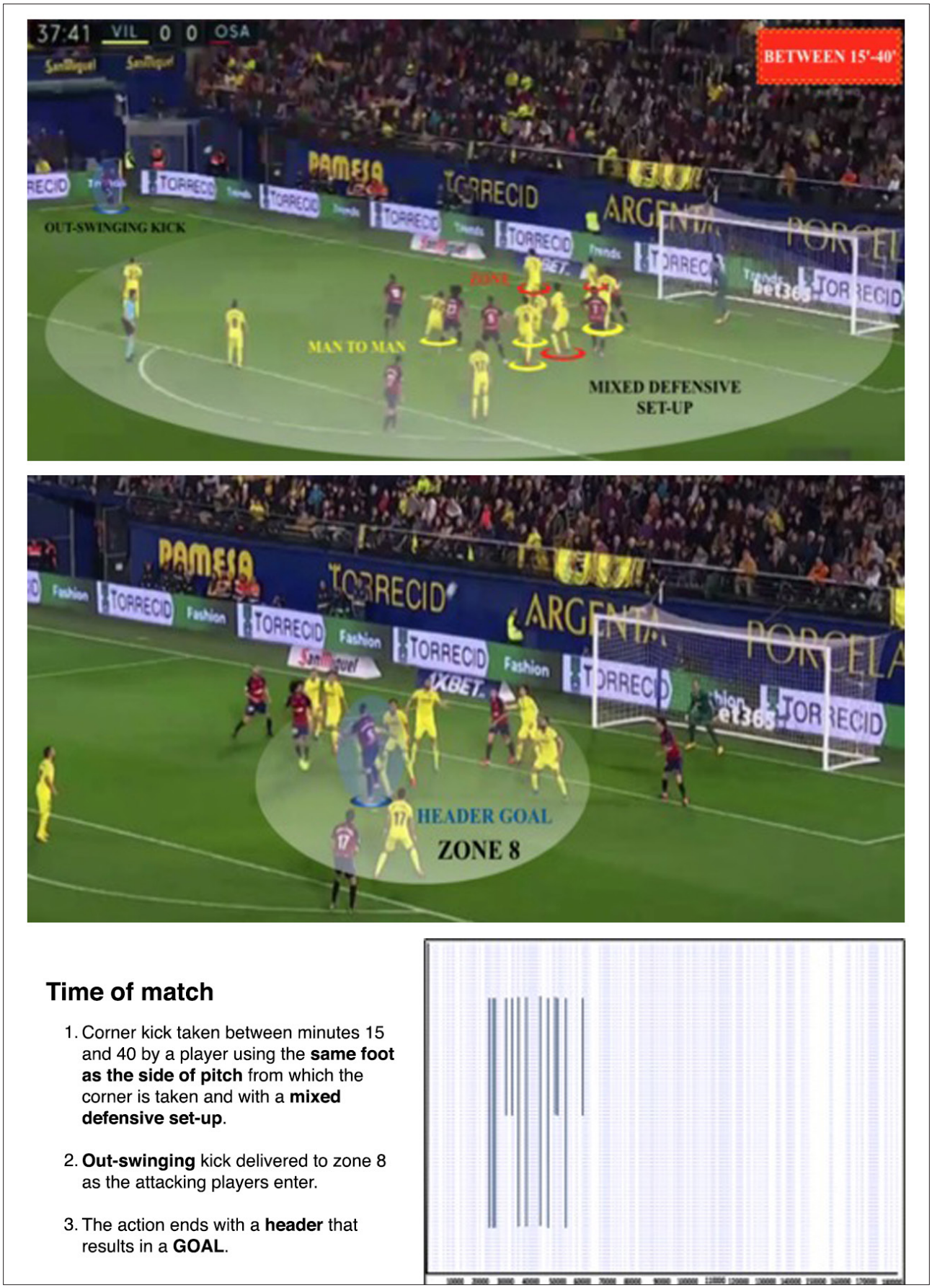


Figure 4.
Representation of the first T-Pattern found to occur in time of match criteria.

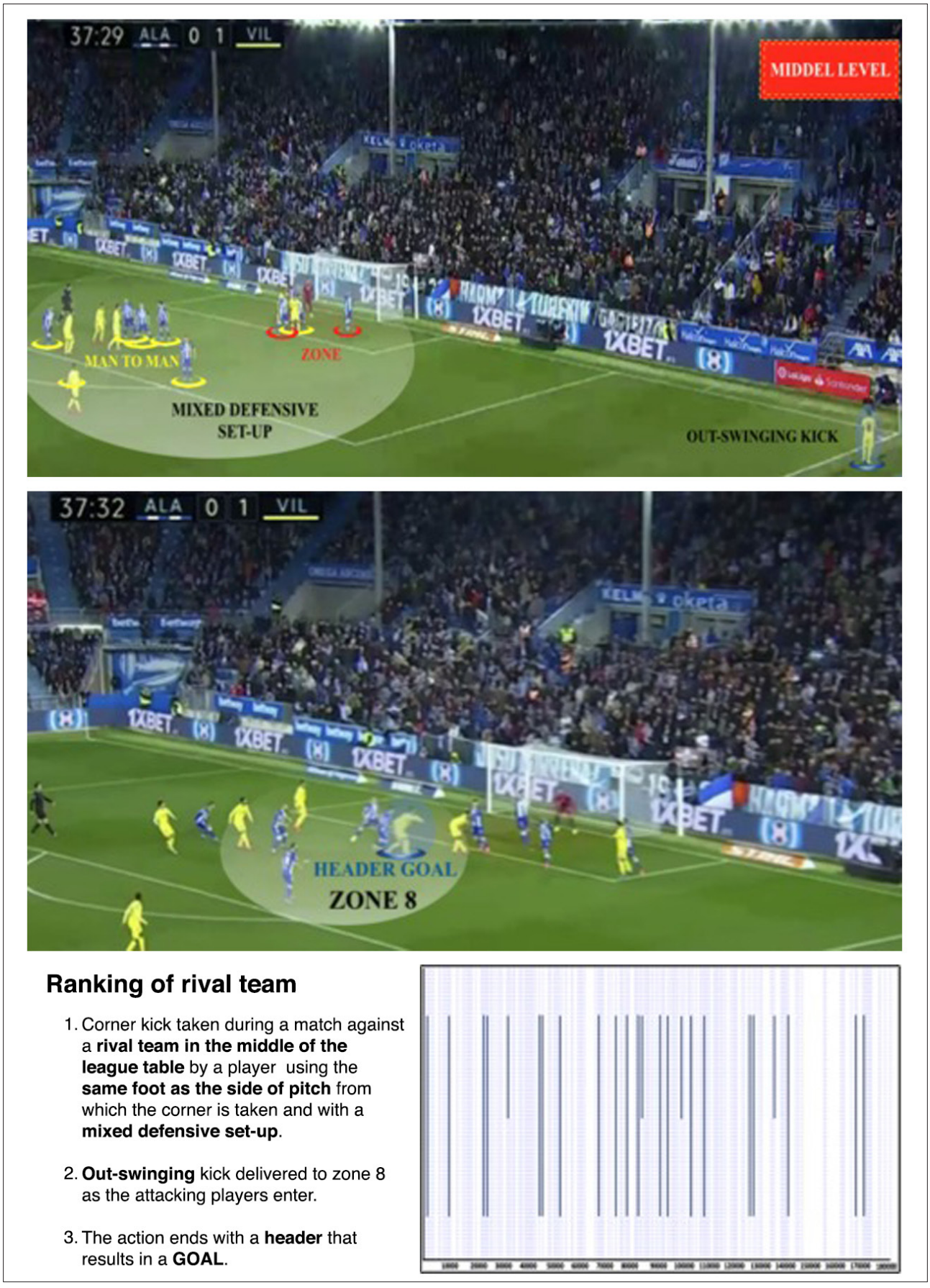


Figure 5.
Representation of the first T-Pattern found to occur in ranking of rival team criteria.

Discusión

Our analysis of corner kick performance supports previous findings showing that various behavioral and situational factors have a decisive effect on match outcome (Alonso, 2001; Fernández-Hermógenes et al., 2017; Teixeira, et al., 2015). Just 29.1% of the kicks analyzed resulted in a shot, again supporting previous findings (Casal et al., 2016; Jiménez et al., 2016; Maneiro et al., 2016; Silva, 2011) and highlighting the low efficacy of this set piece. Even lower rates, have been reported by Borrás et al. (2005) (21.8%), Sainz de Baranda et al. (2012) (23.77%), and Sánchez-Flores et al. (2012) (17.2%).

A total of 2029 corner kicks were taken by first- and second-division teams in the 2016-2017 Spanish league (943 and 1086 kicks, respectively). This corresponds to a mean of 10.04 kicks per match (9.92 in the first division and 10.25 in the second), which is consistent with the mean figures ranging from 9 to 11 reported by Acar et al. 2009; Ardá et al. 2014; Casal et al., 2015b; Maneiro et al., 2016; Maneiro, 2014; Pulling et al., 2013; Sainz de Baranda et al., 2012; Sánchez-Flores et al., 2012; and Silva, 2011), higher than the figures of 7.88 and 6.2 reported by Jiménez et al. (2016) and Yamanaka et al. (1997) respectively, and lower than the figure of 13 reported by Castelo (1999).

The results of our T-pattern analysis show that teams with a home advantage took more corner kicks than visiting teams (Fig 2), supporting the results of the descriptive analyses (1128 kicks taken by teams playing at home versus 901 by those playing away). These results coincide with those obtained in our descriptive analysis that teams with a home advantage took more corner kicks, although Ardá et al. (2014) reported the opposite.

The number of corner kicks taken also varied according to match status (Fig 3) (score at the time of the kick). Our results support previous findings showing that goals resulting from set pieces are decisive for leveling the score (Lago, et al., 2009). As reported by Maneiro (2014) and Maneiro et al. (2016), corner kicks appear to be more successful when taken by a team that is losing or tied. Fernández-Hermógenes et al. (2017), in turn, found that goals resulting from set pieces helped first-division teams increase their lead and second-division teams to equalize or take the lead.

The T-patterns detected in relation to the moment of the match (Fig. 4) when the corner kicks were taken contrast with the findings of our descriptive analysis. According to the T-pattern analysis, corner kicks resulting in a shot were more common in the middle of the first and second halves, whereas the descriptive analysis showed that they were more common at the end of each half, supporting reports by Carling et al. (2005) and Armatas et al. (2007). This difference can be explained by the fact that T-pattern analysis does not focus on a single criterion (in this case, time of kick), but searches for associations between success rates according to a range of criteria, such as kick laterality, ball path, and delivery area.

Few studies have analyzed the influence of rival team ranking on corner kick efficacy. Our T-pattern analysis showed than kicks were more successful when taken by teams playing against teams that finished in the middle or bottom of the league. Fernández-Hermógenes et al. (2017), in turn, found differences between first- and second-division teams, with the latter taking fewer kicks but scoring more as a result. Our results show the contrary: first-division teams took fewer corner kicks but scored more goals.

Conclusions

Our descriptive analysis of factors associated with corner kick efficacy in first- and second-division soccer in Spain shows low success rates. Success was influenced by situational factors (home vs visiting team, ranking, score, time of match), but the influence may be relative as certain categories are larger than others (e.g., there are more teams in the middle of the league than at the bottom). However, if we analyze the situations in greater detail, they all involve factors indirectly related to concentration and physical and mental fatigue.

T-pattern analyses of social interactions are lacking in soccer, but are necessary to uncover recurring patterns that are not visible to the naked eye. The similarities observed between our descriptive analysis of situational variables and the T-patterns detected highlight the potential of this methodology.

The T-pattern analysis showed that the most common corner kick ending in a shot is an out-swinging kick taken using the same foot as the side of the pitch in which the ball is directly delivered to the penalty area and ends in a header. In-swinging corners taken using a switched foot and delivered to the near post and ending in a header were also common. These findings show the potential of T-pattern analysis and provide important information that could be used by both players and coaches to work on improving corner kick performance.

Analysis of situational factors showed that corner kicks were most effective when taken during the middle of the first or second half by a team with a home advantage that was losing or tied and playing against a team ranked in the middle or at the bottom of the league.

One particularly attractive aspect of T-pattern analysis is that despite its complexity it produces very useful visual information, such as tree patterns, histograms, time plots, and tables of concurrent behaviors (in our case with corner kick efficacy as a reference). Time plots could be especially useful for coaches, who could appoint someone to analyze

corner kicks (or other set pieces) during matches and monitor these weekly according to different situational factors, such as the league ranking of the rival team and match location. Over time, this information could provide important insights into how to improve corner kick.

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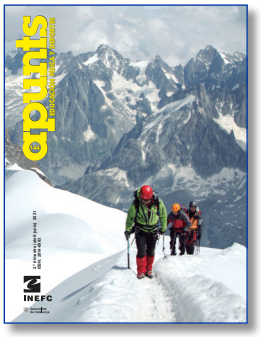

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ATR versus Traditional Periodisation in Adolescent Amateur Tennis Players

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Abstract

The objective of this study was to confirm the most effective periodisation model for improving physical condition in adolescent amateur tennis players: the ATR model or traditional periodisation. Over a period of 38 weeks, 45 amateur tennis players (26 males, 19 females; age: 13.8 (1.09)) were randomly assigned to three different training groups: Control Group (CG), exclusively technical and tactical training; ATR Group (ATRG), technical and tactical training plus physical preparation designed with the ATR model; and Traditional Periodisation Group (TPG), technical and tactical training plus physical preparation designed with traditional periodisation. At the end of the intervention, the CG showed no significant improvements. By contrast, the physical condition of the ATRG and the TPG improved significantly ($p < .05$). Moreover, the ATRG showed a significantly better percentage improvement than the TPG in all the tests performed: 20-m shuttle run test, standing long jump test, medicine ball toss test, spider drill test and sit and reach test. It was concluded that while both periodisation models are useful in improving physical condition, the ATR design is more effective in adolescent amateur tennis players.

Keywords: mesocycle, periodization, physical fitness, training

Introduction

The functional and physiological demands of professional tennis differ from those of the U-18 and U-16 categories. On clay, during competition adolescent male tennis players present a mean heart rate of 135 bpm·min^{-1} and a lactate concentration of 1.54 mmol·l^{-1}. Total match length is approximately 70 minutes, of which only 22.46% is actual playing time. The mean number of shots per point is 3.73 and the mean duration of each point is 5.5 seconds. The total number of points per match is 91.2 (Torres-Luque et al., 2011).

These variables should be taken into account when designing physical training for adolescent tennis players since physical condition is an important performance factor in tennis (Zháněl et al., 2015). In this regard, Ulbricht et al. (2016) observe that adolescent tennis players who obtain better results present higher levels of strength, specific endurance and upper-body power.

Similarly, physical condition plays a significant role in the prevention of injuries in adolescent tennis players due to the convergence of two risk factors that increase the possibilities of sustaining anatomical imbalances: firstly, tennis is an asymmetric sport; secondly, adolescence is a critical period in a human being's life in which accelerated musculoskeletal system growth takes place accompanied by far-reaching physiological changes (Olivera, 2005). Training planning therefore needs to be tailored to each subject's characteristics, particularly bearing in mind the high individual variability at this age (Girard & Millet, 2009).

However, there are additional aspects which largely shape the training planning model to be chosen. They include the variable number of matches and tournaments in which each player participates depending on their wins; the uncertainty of match times; the absence of a reasonable competition-free period of time in the course of the year in which a suitable pre-season stage can be performed and participation in competitions played on different surfaces. Therefore, coaches and physical trainers need to take these factors into consideration to ensure appropriate long-term training for players, avoid over-training and prevent injuries (Colvin & Gladstone, 2016).

In any event, finding a periodisation system that adapts to the characteristics of adolescent tennis players and allows the desired adaptations to be made is difficult. Against this background, the objective of this study was to determine the most effective training planning model to improve physical condition in adolescent amateur tennis players: the ATR (Accumulation, transformation and realization) design or the traditional planning model.

Method

Participants

The study included 45 amateur tennis players (age = 13.8 (1.09); BMI = 18.77 (1.1)), 26 males (regional ranking in the Region of Madrid between positions 71 and 545 and national ranking between positions 382 and 2,647) and 19 females (regional ranking in the Region of Madrid between positions 24 and 239 and national ranking between positions 106 and 1,354). All of them had been playing tennis for at least four years and competed in an average of five tournaments a month between September and June. They had no injuries or health problems preventing them from carrying out the training activities or tests. Attendance was recorded during the study. Of the initial 61-subject sample, 16 players were excluded because they failed to complete 90% of the training sessions. The participants were assigned randomly to one of the following three groups: control group (CG): (n = 15; age: 13.87 (1.19) years; weight = 49.73 (4.23) kg; height: 161.31 (8.69) cm; BMI = 19.12 (1.04)); ATR group (ATRG): (n = 15; age = 14.06 (1.03) years; weight = 49.26 (4.23) kg; height: 162.21 (8.32) cm; BMI = 18.75 (1.02)); and the traditional periodisation group (TPG): (n = 15; age: 13.46 (1.06) years; weight = 48.86 (4.55) kg; height = 163.13 (8.64) cm; BMI = 18.46 (1.23)).

The tennis players and their parents were duly informed about the research objectives, the work methods used and the pre- and post-test tests conducted. The parents also signed an informed consent form giving their approval for their children to be included in this research. The study was performed in compliance with the ethical principles provided for in the Declaration of Helsinki and the approval of the Institutional Review Board of the Bioethics Committee of Prince Sultan University of Riyadh (Saudi Arabia) was secured.

Instruments

The pre-test was conducted in the second week of September and the post-test in the last week of May the following year. Both tests were performed in the same timeslot (between 5.30 pm and 6.30 pm), preceded by a 10-minute warm-up which included an initial five-minute aerobic activation phase and a second active mobility phase. Both the pre-test and post-test were performed following technical and tactical training and after a 24-hour recovery period. The following five tests were used:

20-metre shuttle run test (SRT)

It was used to measure cardiorespiratory endurance on account of its capacity and stability to predict $VO_{2\,max}$ and physical condition, and its reliability and sensitivity for estimating the adaptations accomplished with the training (García & Secchi, 2014). Each subject was asked to run for as long as possible between two lines separated by 20 m in both directions, i.e. there and back, at a pace set by a beep. The speed in the first periods was low but increased every minute. The test ended when the participant stopped because they were tired or because they failed to reach the 20-m mark two consecutive times before the beep went off. The last period or half of it in which the subject managed to complete the drill was recorded. Each participant was allowed to make one attempt.

Standing long jump (SLJ)

This test was used to evaluate explosive leg power on account of its high validity, reliability and applicability (Fernández-Santos et al., 2015). The subject was asked to stand behind a horizontal line with their feet together. From this position, they were to jump as far as possible forwards with both feet together. The rearmost part of the body where the subject landed was taken as the measurement point. Each participant was allowed to make two attempts.

One-handed 3-kg medicine ball toss test (MBTT)

This test was used to evaluate upper-body explosive power on account of its validity, low-risk, ease of performance and the little equipment required (Beckham et al., 2019). The subject was asked to stand behind a straight line, facing the direction of throw, and with the opposite leg to the throwing arm extended in front of them. From this position, they had to try to toss a 3-kg medicine ball as far as possible. The distance measured was between the throw line and the point where the ball hit the ground first. Each participant was allowed to make two attempts.

Spider drill test (SDT)

This test was used to measure agility on account of its ecological validity, reliability and specificity (Huggins et al., 2017). The subject was asked to stand in the centre of the baseline of a tennis court and put their racket on the ground in that same place. At the examiner's signal, they had to place five balls on the racket (one at a time) as fast as possible and do so in the preset order shown in Figure 1. The time was recorded by means of a Casio® HS-80 TW-1EF timer, Japan. Each participant was allowed to make two attempts.

Sit and reach test (S&RT)

This test was used to assess flexibility on account of its high reliability and its validity for estimating hamstring flexibility (Ayala et al., 2012). The participants were asked to sit on the ground with their legs stretched out and their feet upright at a right angle to their legs. Their feet were placed inside a sit-and-reach box. On the top of the box there was a millimetre ruler on a board which the subject had to slowly and progressively move along with their fingers by reaching out as far as possible and holding that position for at least two seconds. At this point the measurement was taken in centimetres. Each participant was allowed to make two attempts.

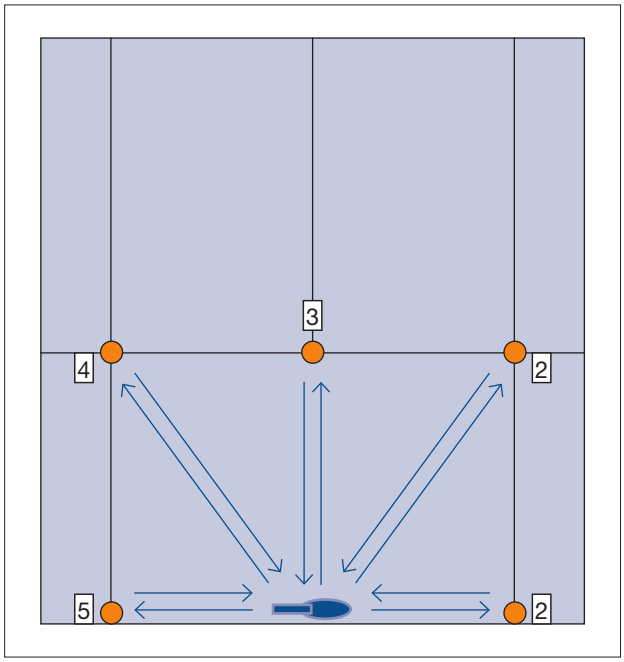

Figure 1
Spider Drill test.

Procedure

Training protocol

The intervention process lasted 38 weeks. The beginning and end coincided with the beginning and end of teaching activities at the subjects' tennis school, or in other words from the second week in September until the last week in May the following year. During this period, the tennis players selected participated in 45 regional tournaments in the Region of Madrid, 41 of them individual and four of them team tournaments. All the participants did five training sessions a week. The technical and tactical training was identical for the three groups and was held from Monday to Friday between 6.30 pm and 8.30 pm. In addition, the ATRG and the TPG did one hour of physical preparation daily (also from Monday to Friday) between 5.30 pm and 6.30 pm. Therefore, the physical training was performed before the technical and tactical training. This sequence was chosen in order to ensure that the presence of neuromuscular fatigue would not negatively impact the adaptations obtained

through the physical conditioning work (Fernandez-Fernandez et al., 2018). Table 1 presents all the parameters pertaining to the volume of training applied to each of the groups during the intervention process.

The physical conditioning work performed by the TPG was designed using traditional periodisation and was produced on the basis of the traditional periodisations provided for in the study performed by Berdejo and González (2008). The ATRG physical preparation was produced using the ATR model. For this purpose, the ATR proposal by Porta and Sanz (2005) was adapted to adolescent amateur tennis players. Figure 2 presents the distribution of the content in the physical preparation of the TPG during the intervention process.

The distribution of the physical work content applied to the ATRG throughout the intervention process and the structure of the macrocycles is shown in Figure 3.

The workload applied to the ATRG and the TPG was identical. To ensure this was the case, the training load components according to Table 2.

Table 1
Volume of work performed by each group.

	GC	TPG	ATRG
Duration of the intervention period	38 weeks	38 weeks	38 weeks
Number of weekly training sessions	5	5	5
Weekly technical and tactical training volume	10 h	10 h	10 h
Weekly physical training volume	0	0	5
Total weekly training volume	10 h	10 h	15 h

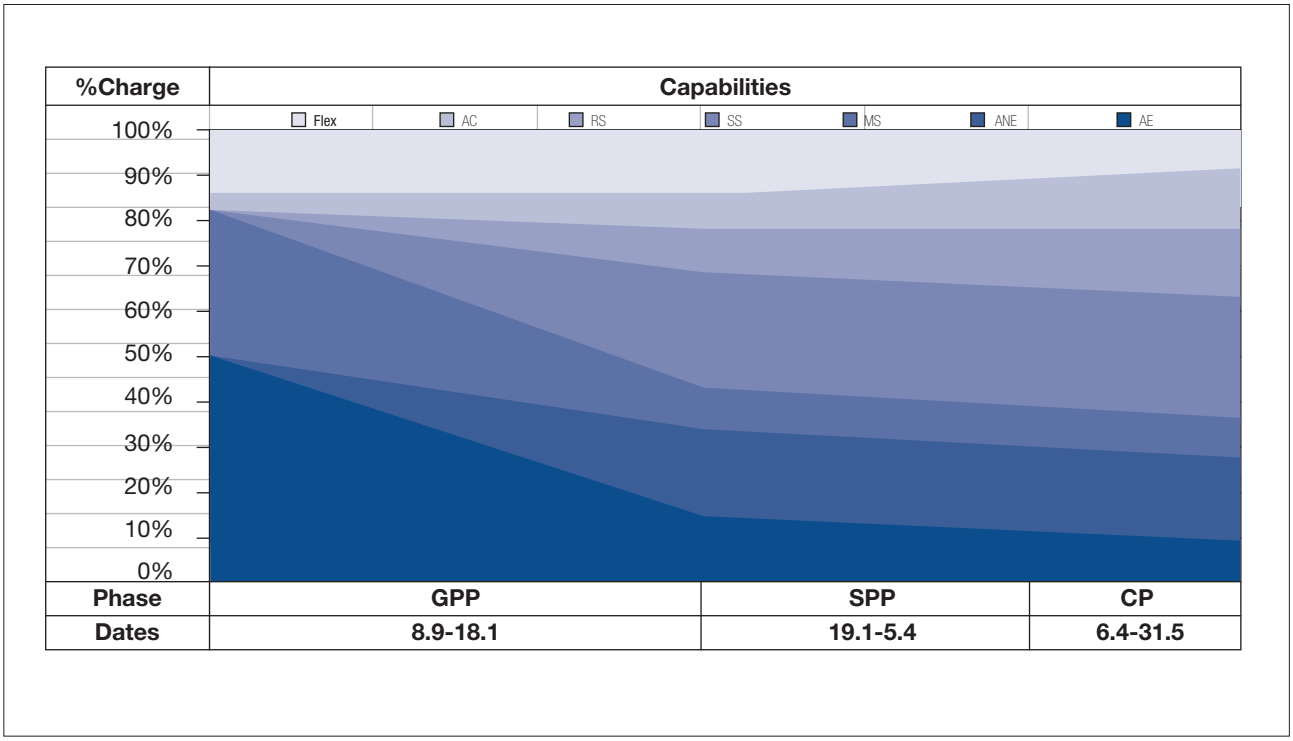

Figure 2
Load dynamics and the distribution of the physical training content in the traditional periodisation model used with the TPG.

Note. Flex: flexibility; AC: acceleration capacity; RS: reaction speed, SS: specific strength; MS: maximum strength; ANE: anaerobic endurance, AE: aerobic endurance; GPP: General preparation period; SPP: Specific preparatory period; CP: Competitive period.

No. microcycles	7	4	2	6	5	2	5	4	3
Mesocycle	A	T	R	A	T	R	A	T	R
Main training content	FM RB III	SS SR	CR RS AC	MS BR III	SS SR	CR RS AC	MS BR III	SS SR	CR RS AC
Macrocycle	I			II			III		
Dates	8 Sep-7 Dec			8 Dec-8 Mar			9 Mar-31 May		

Figure 3
Structure of the training macrocycles used with the ATRG.

Note. A: accumulation; T: transformation; P: performance; MS: maximum strength; BR III: base endurance III; SS: specific strength; SR: specific endurance; CR: competition rate; RS: reaction speed; AC: acceleration capacity.

Table 2
Parameters used to quantify the training load of the ATRG and TPG groups.

Capacity	Parameters used for volume measurement	Parameters used for intensity meas-urement
Strength	Series, repetitions and kilograms	Work percentage with regard to 1RM test
Endurance	Distance travelled, time trained, number of series and repetitions	Heart rate
Speed	Distance travelled, number of series	Percentage with regard to maximum speed or time taken to cover a given distance
Flexibility	Series, seconds maintaining posture	Subject-perceived degree of stress

The training methods used to improve physical condition in both experimental groups were the same and were tailored to the tennis players' characteristics and objectives (Table 3). However, the use of these methods in the course of the training cycle differed depending on the planning model used. The physical preparation of the TPG was structured into a single macrocycle and that of the ATRG into three macrocycles. In both cases, a smaller number of macrocycles was used because the athletes were adolescents and tennis is a sport in which endurance plays an important role in terms of performance (Navarro, 1999).

The physical training time applied to each tennis player was individualised. The 1RM test was used to gauge strength training intensity in the following exercises: sit-up, leg curls, bench press, pullover, pulley triceps, biceps curl with dumbbells and reverse flies. Endurance training intensity was established by means of the information obtained in an incremental exercise test (aerobic and anaerobic threshold, $VO_{2\ max.}$ and $HR_{max.}$). This test was done on a Matrix® Treadmill T70 XIR Minneapolis (United States) and with a Metamax® 3B spiroergometer, Leipzig, (Germany), while heart rate was recorded with a Polar S610i monitor, Kempele (Finland). The protocol was as follows: a 10-minute warm-up at 8 kph followed by a 5-min rest, after which the test began at a speed of 8 kph with a 1% inclination. The speed was increased by 0.5 kph every 30 seconds until the end of the test. The 30-metre test was used to determine work intensity in the speed training. The subjects started from the racing standing position. The time was logged with two Witty-Gate photoelectric cells (Microgate®, Bolzano, Italy) connected to a Microgate Witty Timer receiver. Both experimental groups performed these three tests on three occasions during the intervention, albeit on different dates due to the planning design. More specifically, the ATRG performed them between

Table 3
Training methods and systems used with the TPG and ATRG groups.

Capacity	Training methods and sys-tems	Activities or exercise
Maximum strength	I: 65-80%; S: 3-5; R: 6-12; Rt: 2-3'	Crunches, lower-back on Roman chair, sit-ups, leg curls, bench press, pullover, pulley triceps, biceps curl with dumbbells, reverse flies
Specific strength	Plyometric method (I: Heights of 40-60 cm; S:3-5; R: 5-10; Rt: 3') Multiple horizontal jumps (S: 3-5; R: 5-10; Rt: 3') Multiple throws: (I: 30-60%; S: 3-5; R: 5-10; Rt: 3')	Plyometry: drop from a height of 40-60 cm followed by a quick jump upwards Multiple forward jumps: travel as far as possible with a set number of jumps Multiple tosses of a medicine ball simulating serve, forehand and backhand technique
Base endurance III/ Aerobic endurance	Variable continuous method: (I:65%-75% Max HR; Du: 30-60')	Aerobic pace run (65-75% Max HR) combined with short (5-20") high-intensity actions (85-90% Max HR) including changes of pace, direction and accelerations and decelerations
Specific endurance/ Anaerobic endurance	Intensive interval method with short intervals: (I: W 90-100% Max HR, Rt 120 bpm; S: 3-4; R: 3-4; Du: 20"-30"; Rt: 2-3'/5-10') Intensive interval method with extremely short intervals: (I:W95%-100 Max HR – Rt 120 ppm; S: 3-4; R: 3-4; Du: 8"-15"; Rt: 2-3'/5-10')	On-court exercises with ball and racket, including specific movements and basic shots (serve, forehand, backhand, volley and smash): Example 1. Serve-forehand-backhand Example 2. Serve-forehand-backhand-forehand volley-backhand volley-smash Example 3. Serve-forehand volley-backhand volley:
Reaction speed	Starts and exercises and reaction games	Example 1. Starts from different positions with visual and auditory stimuli: lying down (face-up, face-down), seated, back turned, standing, racing standing and crouching start. Example 2. Throw a ball at the tennis player, who has to catch it as quickly as possible. Example 3. The tennis player stands inside a square marked out by four numbered cones. The trainer calls out the numbers and the player has to touch them as fast as possible.
Acceleration capacity.	Racing technique exercises Chasing and speed games Slopes and dragging: (I:95-100%, R:4-8; Di: 10-30 m; Rt: 1'-3')	Racing technique exercises. Examples: Skipping, progressive skipping, heels to buttocks, high and long jumps. Speed and chasing games. Examples: run after someone placed 2 metres away. In two groups of five tennis players standing opposite each other, one is even and the other odd. The teacher says a number, and if it is even, the even group has to chase the odd group and the other way round. Slopes and dragging: slopes with a 6% off-level. Dragging with a speed loss of 10% of their record for the distance.
Flexibility	Active and passive stretching and PNF	General stretching exercises to improve the flexibility of the body's main joints and muscle groups by means of active and passive stretching. Stretching exercises targeting the short muscles and PNF.

Note. I: intensity: S: series: R: repetitions; Du: duration; Max HR.: Maximum heart rate; bpm: beats per minute; Rt: rest; Di: distance; W: work time.

8 and 14 May, between 8 and 14 December and between 9 and 15 March. The TPG performed them between 8 and 14 May, between 19 and 25 January and between 6 and 12 April.

Statistical analysis

The data were summarised using the arithmetic mean format (standard deviation (SD)). The distribution hypotheses were verified by means of the Shapiro-Francia test and the asymmetry and Kurtosis tests. In order to estimate the effect size of the improvements produced by the different trainings, the percentage of relative change ([post – pre] / pre * 100) was calculated for each group first. The Student t-test for one sample was used to statistically evaluate the effect produced in each group, comparing each mean with regard to zero, as well as the calculation of the 95% confidence interval (CI) for these estimates. The differences between groups were analysed by means of a single-factor analysis of variance (ANOVA) and the subsequent application of Tukey's HSD test. The ANOVA's effect size was estimated by means of the η^2 parameter. The level of statistical significance was set at $\alpha = .05$. All the analyses were performed in Stata 13.1 (StataCorp, College Station, Texas).

Results

As is shown in Table 4, no statistically significant changes were observed in the CG between the pre-test and the post-test, whereas significant improvements were observed in all the tests in the two experimental groups (TPG and ATRG). According to these results, all the ANOVA presented significant differences between the groups in all the tests, with large effect sizes (S&RT, $F(2.44) = 7.1$, $p = .002$, $\eta^2 = .25$; SLJ, $F(2.44) = 82.71$, $p < .001$, $\eta^2 = .80$; MBTT, $F(2.44) = 13.91$, $p < .001$, $\eta^2 = .36$; SDT, $F(2.44) = 63.73$, $p < .001$, $\eta^2 = .74$; SRT, $F(2.44) = 7.2$, $p < .002$, $\eta^2 = .25$).

After differences were observed in the group effect, the post-hoc analysis of the ANOVA showed that the improvement produced by the TPG was not significantly greater than that which was produced by the CG in any of the tests (S&RT, $p = .994$; SLJ, $p = .135$; MBTT, $p = .061$; SDT, $p = .283$; 20-metre SRT, p = .678). However, the ATRG presented a significantly greater improvement both in comparison with the CG (S&RT, $p = .007$; SLJ, $p = < .001$; MBTT, $p = < .001$; SDT, $p = < .001$; 20-metre SRT, $p = .002$), and in comparison with the TPG (S&RT, $p = .005$; SLJ, $p = < .001$; MBTT, $p = .015$; SDT, $p = < .001$; 20-metre SRT, $p = .022$).

Table 4
Summary of the pre-post intragroup results and differences.

	CG (*n* = 15)				TPG (*n* = 15)				ATR (*n* = 15)			
			% change				% change				% change	
	Pre	Post	[IC 95%]	*p*	Pre	Post	[IC 95%]	*p*	Pre	Post	[IC 95%]	*p*
S&RT	11.3	11.9	11.1	.118	10	11.1	10.3	.049	10.3	13.5	36.9	<.001
	(4.4)	(4.0)	[-3.2, 25.5]		(3.2)	(3.5)	[0.1, 20.5]		(3.7)	(3.6)	[25.3, 48.6]	
SLJ	176	176.7	0.5	.236	177.5	180.1	1.6	<.001	179	191.1	6.8	<.001
	(25.9)	(24.1)	[-0.4, 1.5]		(26.8)	(25.6)	[0.8, 2.3]		(17.8)	(17.5)	[6.1, 7.5]	
MBTT	717.4	718.5	0.2	.342	720.6	727.9	1	<.001	725.5	739.1	2	<.001
	(155.3)	(154.4)	[-0.2, 0.7]		(144.2)	(146.3)	[0.7, 1.4]		(142.6)	(140.2)	[1.3, 2.7]	
SDT	19.7	19.6	-0.2	.153	19.5	19.3	-0.7	.006	19.4	18.7	-3.4	<.001
	(1.8)	(1.9)	[-0.6, 0.1]		(1.8)	(1.7)	[-1.2, -0.2]		(1.6)	(1.6)	[-4, -2.9]	
SRT	6.8	7	3.4	.188	7	7.4	6.2	.026	7	8.1	15.5	<.001
	(1.2)	(1.2)	[-1.9, 8.7]		(1.2)	(1.2)	[0.8, 11.6]		(1.1)	(1.2)	[11.1, 20]	

Note. The pre- and post-values represent the mean (SD); the CI95% is the confidence interval for the estimated change of percentage value. The *p* values were calculated by comparing the percentage of change with regard to zero by means of the Student t-test for one sample. S&RT: Sit and reach test; SLJ: Standing long jump; MBTT: One-handed 3-kg medicine ball toss test; SDT: Spider drill test; SRT: 20-metre shuttle run test; CG: Control Group; TPG: Traditional Periodization Group; ATRG: ATR Group

Discussion

The results showed that the technical and tactical training performed over 38 weeks at a rate of 10 hours a week did not make it possible to improve physical condition levels, since the CG did not obtain significantly greater scores in the post-test compared with the pre-test. Therefore, it might be thought that the physical improvements achieved by both the ATRG and the TPG may be attributed to the physical preparation done. It was also found that the results obtained by the ATRG were significantly better than those obtained by the TPG, although the workload applied to both experimental groups was identical and the training methods used were the same. Therefore, although some authors consider that from the scientific standpoint the ATR model is no more validated than the traditional periodisation model (Hellard et al., 2017), in view of the results of this research the interpretation must be that load distribution in the ATR design is more effective, at least in the case of physical condition. This might be due to a number of reasons. Firstly, the simultaneous development of several physical capacities might, as a result of their incompatibility, make it difficult to achieve adaptations. By contrast, targeting a smaller number of capacities within each training mesocycle would avoid interferences (Issurin, 2014; Navarro, 1999).

The use of concentrated load models also ensures suitable implementation of training continuity and progression principles since the work stimuli are applied with the frequency and the duration needed to achieve adaptations. Conversely, the use of workloads with multiple objectives would make it difficult for the stimulus to reach the minimum threshold needed for the body to attain a favourable response (Navarro, 1999; Issurin, 2014).

Applying the traditional periodisation model on a prolonged basis has been associated with excess fatigue in view of the increased release of stress hormones and creatine phosphokinase. Under these circumstances, the possibility of obtaining adaptations through the training process would be compromised (Issurin, 2014).

Similarly, the improvement of capacities such as speed and power could be hampered by a high training volume. It should be remembered that in the ATR design, training volume is reduced considerably in the transformation mesocycle and particularly in the performance mesocycle, and it is in the course of these mesocyles when the power and speed work is done due to the low residual effect of both capacities. In contrast, speed and power training in traditional periodisation is combined with capacities such as aerobic endurance and maximum strength, the development of which involves considerable training volume (Navarro, 1999).

Issurin (2014) and Navarro (1999) also contend that the ATR design could be superior to the traditional model due to the fact that the mesocycles are structured according to the residual effects of the training. The general exercises precede the specific ones, and in turn the latter are performed before the competitive exercises. Therefore, the sequencing of the different cycles follows a logical order. Similarly, the duration of each mesocycle is not set only as a function of external aspects such as the competition calendar since the time and the pace of improvement of the capacities to be developed are also factored in (González et al., 2015). In this way, the time structure of the ATR model is tailored to the processes of biological adaptation to physical exercise. However, Verkhoshansky (1998) considers that there is an arbitrary division of training cycles in the traditional periodisation model. Issurin (2016) adds that the ATR model is very useful in sports in which performance depends on several physical capacities and that it is applicable in non-professional sportspeople, in one-against-one and team sports and also in sports that call for high levels of strength or stamina. He also states that the ATR design is an effective alternative to the traditional periodisation model. Moreover, Porta and Sanz (2005) assert that the advantage of the ATR model lies in the fact that the training effects are selective, immediate and accumulative.

With regard to previous studies in which the most efficient methodology for improving physical condition in sports were studied, it should be noted that many of them focus on a small number of physical capacities, particularly strength and speed. Furthermore, the intervention designs used normally lasted less than 16 weeks. In these conditions, it is difficult to draw conclusions in order to determine which model of periodisation is most effective in each sport, since most of the athletes need to improve not only their levels of strength, power and speed but also their other physical capacities and motor qualities (Cissik et al., 2008).

In tennis, the efficacy of different training planning models in non-professional sportspeople has been analysed in another three studies. Vera and Mariño (2013), in research conducted over a period of 16 weeks with university tennis players, concluded that the accentuated multilateral model generated better outcomes than both the ATR approach and traditional periodisation in technique, speed and explosive force.

Polanco and Mariño (2019), following a five-week intervention with university tennis players, found that both the ATR design and tactical periodisation helped to improve technical effectiveness and intermittent endurance. Nevertheless, tactical periodisation generated better

technical results, whereas the ATR model yielded superior improvements in intermittent endurance, albeit in out-of-context playing conditions.

Carvajal and Joya (2019), in a 13-week study with adolescent tennis players, observed that the ATR approach delivered significant improvements in levels of strength, cardiovascular endurance and agility, although this research only had one experimental group and no control group, meaning that the true scope of the adaptations achieved could not be verified.

Block models have also been used in team sports, although some authors advise against this on the grounds that integrating methodologies are more effective in sports involving numerous performance factors. These authors argue that training conditional, coordination, socio-affective and cognitive aspects separately is complicated (Martín et al., 2013) and contend that the use of block models such as the ATR design is not appropriate in these sports on account of the high number of competitions held in the course of the year (Krasilshchikov, 2010). Despite these approaches, Castillo Rodríguez (2011), in a study performed with two groups of amateur football players (one junior and one senior), showed the efficacy of the ATR design in the improvement of sports performance. Moreover, Gavanda et al. (2018) found that block versus daily undulating periodisation applied to adolescent American football players yields similar improvements in strength and performance.

Many of these studies analysed therefore prove that block models such as the ATR design make it possible to improve physical condition in different sports. However, this study also confirmed that the ATR approach leads to good results in one-against-one sports such as tennis in which there are socio-motor situations. This system has also been shown to be effective in youth sport (12-16 years) and useful in sports where performance is shaped (among other skills and capacities) by endurance. Nevertheless, due to the small number of articles that have analysed the efficacy of different planning models in tennis, this study's findings need to be confirmed by subsequent research.

Conclusion

Both the traditional periodisation model and the ATR design applied to adolescent amateur tennis players make it possible to improve their levels of flexibility, explosive power, agility and cardiovascular endurance. However, the ATR approach provides significantly better results than traditional periodisation in each of the capacities mentioned.

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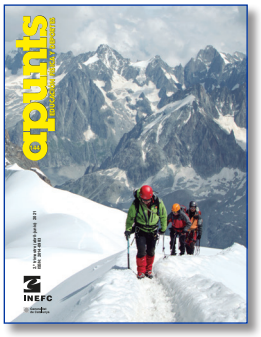

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Short Distance Sprint Performance in Elite Wheelchair Basketball Women Players: Influence of Functional Classification

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Abstract

The aim of this study was to analyse the short-distance sprint performance (SDSP) differences between functional International Wheelchair Basketball Federation (IWBF) classes in elite wheelchair basketball (WB) women players. Additionally, the association between WB experience and the IWBF functional classification score and SDSP was assessed. Sixteen WB women players belonging to the Spanish national WB team were grouped according to the functional IWBF classes: group 1 (class 1 and 1.5), group 2 (class 2 and 2.5), group 3 (class 3 and 3.5) and group 4 (class 4 and 4.5). Each participant completed 2 sets of 12-m wheeling sprints at maximum speed, and split times at 3, 5 and 12 m were recorded. Major significant differences were observed in SDSP between groups 1 and 4 (p <.05; effect size [ES] range: -2.27 – 4.02) and, while not significant, a clear trend in which the higher the functional IWBF classification the higher the SDSP was observed. Moreover, we found a significant strong association between the functional IWBF classification individual score and the SDSP (p < .05; r_s range: 0.61 – 0.71). The SDSP test (split times at 3, 5 and 12 m) would therefore seem to be sufficiently sensitive to reflect the level of functional ability in elite WB women.

Keywords: paralympic sport, field-based test.

Introduction

There are five major functional International Wheelchair Basketball Federation (IWBF) classes in wheelchair basketball (WB)t: 1.0, 2.0, 3.0, 4.0 and 4.5 (IWBF Player Classification Commision, 2014). Although trunk, lower limb and upper limb function are important for determining player class, trunk movement and stability play a major role in determining the classification (Tachibana et al., 2019; Y. C. Vanlandewijck et al., 2011). Although there is no consensus, a higher class would appear to denote a higher level of functional abilities on the court (Marszałek et al., 2019; Y. C. Vanlandewijck et al., 2004). In this regard, a class 1.0 player presents a low degree of voluntary control in any plane, relying on their arms for support in all plane movements (Tachibana et al., 2019). On the contrary, a class 4.5 player presents mobility in all planes (Tachibana et al., 2019). In order to preserve fair play in competition, the sum of the points of the five players on the court cannot be higher than 14 (IWBF Executive Council, 2018) and each player's functional class is evaluated by the practice and game observation during matches.

Although WB is probably one of the most popular sports for the disabled (Gil-Agudo et al., 2010), the evidence base supporting performance is still insufficient, particularly when compared to able-bodied sport (Paulson & Goosey-Tolfrey, 2017). Moreover, little is known about the players' physical condition (Paulson & Goosey-Tolfrey, 2017). Previous studies have shown that WB match-play is characterized by high-intensity intermittent efforts (Coutts, 1992; Paulson & Goosey-Tolfrey, 2017), where accelerative wheeling sprint capacity, from a standstill (Ferro et al., 2016) and over short distances (driving forward from 3 to 12 m), might play an important role in game performance (De Witte et al., 2017). Twenty-metre field-based sprint tests have been used to assess WB women players' sprint capacity according to their functional classification level (Molik et al., 2013; Tachibana et al., 2019), although only the study by Molik et al. (2013) also recorded sprint performance over a short distance (5 m), which might be much more related to specific WB competitive needs (De Witte et al., 2017). However, in that study, the participants were divided into two functional groups only (1.0–2.5 group and 3.0–4.5 group). Therefore, the relationship between the functional IWBF classification level and short-distance sprint performance (SDSP) remains unclear.

To the best of our knowledge, no studies have analysed the SDSP (i.e., 3, 5 and 12 m) in elite WB women. Moreover, there is a lack of evidence about differences in wheeling SDSP between IWBF functional class groups. Therefore, this study set out to analyse the SDSP differences between functional classification level in elite WB women. In addition, the association between WB experience and IWBF functional classification score with SDSP was assessed.

Methodology

Sixteen WB women players belonging to the Spanish national WB team participated in this study (Table 1). All the participants belonged to the Spanish Sports Federation for People with Physical Disabilities (FEDDF) and were classified in accordance with the IWBF Classification Committee (Table 1). Both are requisites for participating in official events for people in the physical disabilities' category. Players were subsequently classified as follows: group 1 (class 1 and 1.5), group 2 (class 2 and 2.5), group 3 (class 3 and 3.5) and group 4 (class 4 and 4.5). The institutional research ethics committee of the Catalan Sports Council (No. 01_2017_CEICGC) approved this study. Prior to involvement in the investigation, all participants gave their written informed consent after a detailed written and oral explanation of the potential risks and benefits of participating in this study, as provided for in the Declaration of Helsinki (2013).

Each participant completed 2 sets of 12-m wheeling sprints at maximum speed, with a 5-minute rest (1 minute of active recovery and 4 minutes of passive recovery) between sets (García-Fresneda et al., 2019). The best attempt was recorded for further analyses. The participants were placed at 0.5 m from the starting point and began when they felt ready. Time was recorded using photocell gates (Microgate, Polifemo Radio Ligth®, Bolzano, Italy) with an accuracy of ± 0.001 s (Yanci et al., 2015). The timer was activated automati¬cally as the players passed the first timing gate at the 0.0-m mark and split times were then recorded at 3, 5 and 12 m. The 12-m sprint test has previously presented a very high reliability measured with radar in male Rugby wheelchair players (intraclass correlation coefficient [ICC] range = .97–.99) (García-Fresneda et al., 2019) and measured with photocells in WB men (coefficient of variation [CV] of 1.41% at 5 m) (Yanci et al., 2015).

Values are presented as mean ± SD. Data analysis was performed using IBM SPSS v20.0 (IBM Corp., Armonk, NY, USA). The data were screened for normality of distribution (Shapiro-Wilk). Homogeneity of variance was examined by Levene's test. One-way analyses of variance (ANOVA) were used to evaluate differences in normally-distributed dependent variables across IWBF classification groups. In the event of a difference, Bonferroni post hoc tests were used to identify any localized effects. Magnitudes of difference were classed as trivial (<0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (> 1.2–2.0) and very large (> 2.0–4.0) (Batterham & Hopkins, 2006). To analyze the association between 'WB experience' and 'IWBF functional classification score' with SDSP, Pearson's correlation coefficient or Spearman's rank correlation coefficient were used depending on the variable distribution, with thresholds of: .40– .59, moderate; .60–.79, strong; .80–1, very strong. Alpha was set at $p < .05$.

Table 1
Wheelchair basketball player characteristics. Results are in means SD.

	1 (1.0 and 1.5) (n = 4)	2 (2.0 and 2.5) (n = 5)	3 (3.0 and 3.5) (n = 4)	4 (4.0 and 4.5) (n = 3)
Age (years)	23.3 ± 4.5	29.2 ± 5.6	21.0 ± 2.9	30.3 ± 5.1
Total mass (body mass + wheelchair mass) (kg)	63.3 ± 8.0	66.8 ± 12.7	78.3 ± 16.9	93.1 ± 9.2
WB training experience (years)	3.8 ± 1.0	11.6 ± 2.9**## (ES = 2.79 and 3.59, very large)	4.3 ± 2.5	11.0 ± 3.5*# (ES = 2.69 and 2.20, very large)

Note: IWBF = International Wheelchair Basketball Federation. ES = Cohen's d effect size. * and ** Significantly different from group 1 at a $p < .05$ and $p < .01$ level, respectively. # and ## Significantly different from group 3 at a $p < .05$ and $p < .01$ level, respectively.

Results

Regarding the WB players' characteristics, significant differences were only found in WB years of experience (see Table 1).

Very large significant differences between groups 1 and 4 were found in all sprint distances measured (time at 3, 5 and 12 m) (Table 2) (Figure 1). While not significant, important meaningful differences were also found between groups 1 and 3 in sprint performance (ES = -1.83, large [90% CI: -3.21 – 0.45], ES = -2.04, very large [90% CI: -3.47– 0.61], and ES = -1.13, moderate [90% CI: -2.38 – 0.12] for 3, 5 and 12 m times, respectively) (Figure 1). Large to very large meaningful differences were also found between groups 2 and 4 in sprint performance (ES = -1.61, large [90% CI: -2.87 – 0.34], ES = -1.63, large [90% CI: -2.89 – 0.36], and ES = -2.15, very large [90% CI: -3.53 – 0.77] for the 3, 5 and 12 m times, respectively). (Figure 1).

While training experience did not show any correlation with sprint performance, the functional IWBF classification score was strongly (Spearman's rank correlation coefficient range: .61 – .71) and significantly ($p < .05$) correlated with split times used to assess wheeling sprint performance (Figure 2).

Table 2
Short-Distance Sprint Performance.

IWBF classification group	3 m time (s)	5 m time (s)	12 m time (s)
1 (1.0 and 1.5) (n = 4)	1.45 ± 0.06	2.13 ± 0.08	4.27 ± 0.21
2 (2.0 and 2.5) (n = 5)	1.39 ± 0.11	2.06 ± 0.18	4.01 ± 0.24
3 (3.0 and 3.5) (n = 4)	1.31 ± 0.09	1.96 ± 0.09	3.99 ± 0.28
4 (4.0 and 4.5) (n=3)	1.16 ± 0.17*	1.79 ± 0.15*	3.62 ± 0.09*

Note. Mean ± SD wheeling sprint values. IWBF = International Wheelchair Basketball Federation. *Significantly different from group 1 at a $p < .05$ level.

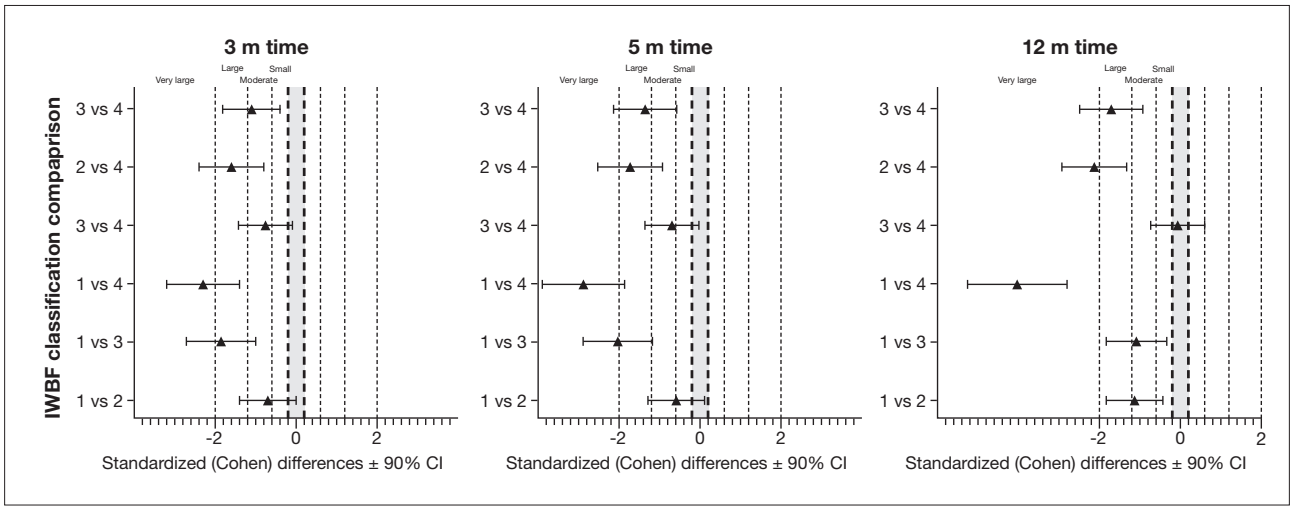

Figure 1
Standardized (Cohen d) differences ± 90% confidence interval for wheeling short sprint-time intervals for the different groups based on IWBF classification groups (group 1: 1 and 1.5 [n = 4]; group 2: 2 and 2.5 [n = 5]; group 3: 3 and 3.5 [n = 4], and group 4: 4 and 4.5 [n = 3]). IWBF = International Wheelchair Basketball Federation.

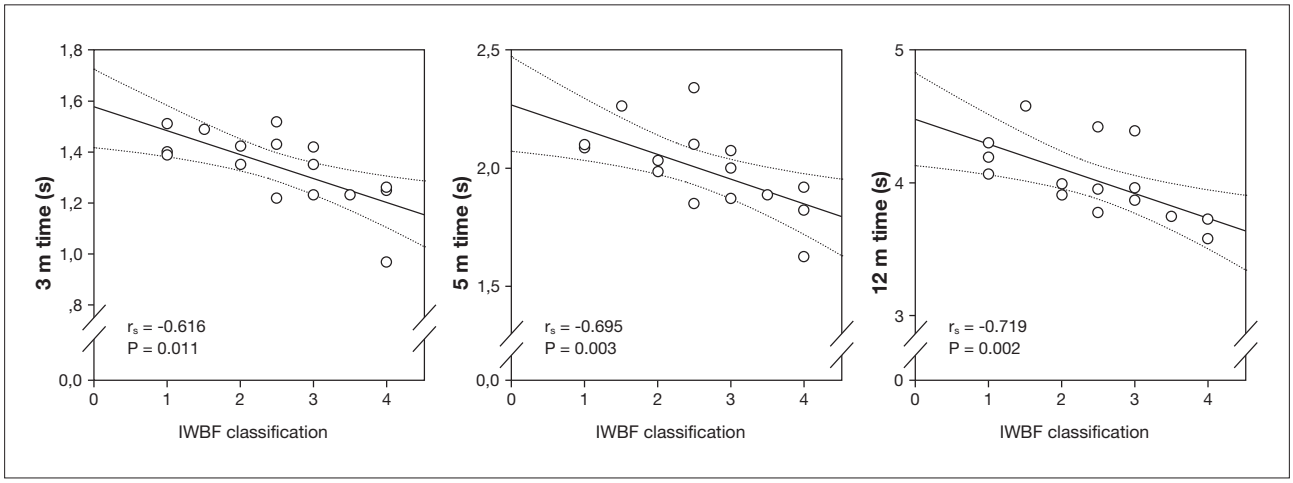

Figure 2
Correlation between the functional IWBF classification score and sprint performance split times at 3, 5 and 12 m respectively. r_s = Spearman's rank correlation coefficient. Dotted lines = 95% confidence intervals.

Conclusions

The main contribution of this study is the characterization of the SDSP profile in elite WB women players, taking the influence of the functional IWBF classification groups into account. In this regard, very large significant differences were observed in SDSP between groups 1 and 4. Moreover, a significant strong association was found between the functional IWBF classification individual score and the SDSP.

Short-distance sprint performance: differences between groups

The results from this study showed a clear trend in which the higher the functional IWBF classification the higher the SDSP. Although, statistically significant, very large differences were only observed in SDSP between groups 1 and 4, small to moderate, and moderate to large meaningful differences were observed between groups 1 and 2, and 1 and 3, respectively. In this regard, our results are in line with the only previous study that has analyzed 5-m sprint performance in elite WB women players, taking functional IWBF classification (Molik et al., 2013) into account. Those authors found significant differences in 5-m sprint times between category A (class 1 to 2.5) and B (class 3 to 4.5) (2.2 ± 0.1 and 2.0 ± 0.2 s, respectively, $p = .03$). Moreover, significant differences between functional groups 1 and 4 in 20-m sprint performance have also been reported in the literature and no significant differences between adjacent

groups (i.e., between groups 1 and 2, groups 2 and 3, and groups 3 and 4) (Tachibana et al., 2019), as in the case of our study. The differences between functional groups in sprint performance have mostly been accounted for in the literature by the influence of WB (or wheelchair) experience (Molik et al., 2013; Tachibana et al., 2019). While WB experience might play a role in the superior sprint performance exhibited by group 4 (particularly if compared to group 1), the present results would seem to indicate that the higher level of functionality might be much more decisive, since no differences were observed between groups 1 and 3 in WB experience, although large differences were observed in SDSP, especially at 3 and 5 m. This notion is also supported by the fact that while no differences were observed between groups 2 and 4 in WB experience, large to very large SDSP differences were obtained. Therefore, while the role of WB experience in these differences might be not ruled out, functionality might seem to play a major role in SDSP. The larger range of action and the higher trunk control of the functional classification group 4 (Vanlandewijck et al., 2001) might be related to a greater wheeling propulsion capacity. These functional advantages could explain the differences observed in SDSP between groups.

IWBF classification and sprint performance association

Contrary to previous reports in 5-m sprint measures, where no association was found between sprint performance and functional IWBF classification (Molik et al., 2013), in this study, significant strong correlations were found between SDSP and the functional IWBF classification individual score. Previous findings in WB men players (Gil et al., 2015; Yanci et al., 2015) indicate that sprinting abilities were more influenced by WB (or wheelchair) experience rather than by the functional classification. However, we did not find any statistical association between SDSP and WB training experience. Thus, our correlational results reinforce the notion that while training status and technical experience were likely to contribute to SDSP (especially because of the very large significant differences in WB training experience between groups 1 and 4), functionality seemed to play a more important role, confirming that the functional classification groups of women wheelchair basketball players is an accurate representation of their level of functional ability (Vanlandewijck et al., 2004).

In conclusion, a clear trend in which the higher the functional IWBF classification the higher the SDSP was obtained in elite WB women. The SDSP test (split times at 3, 5 and 12 m) would therefore appear to be sufficiently sensitive to reflect the level of functional ability in elite WB women players.

Acknowledgements

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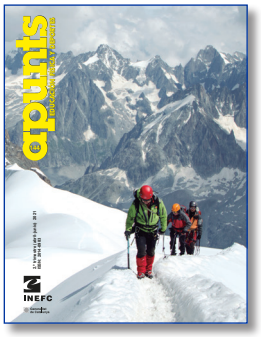

The Viewing of Soccer Programming in the Mass Media: Impact on Spectators' Moral Functioning and Aggressiveness

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Climbers ascending to the summit of Mont Blanc. Chamonix (France)
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Abstract

With the appearance of the mass media, soccer has turned into a mass spectacle. Unfortunately it has coincided with the worst manifestations of violence in modern sports. It has been argued that this kind of behavior could be related to the spectacle itself and its handling by the mass media. The purpose of this doctoral thesis was to analyze, for the first time, the impact of the mass media on spectators' moral functioning, aggressiveness, and meta-perception of goal orientation.

This research is organized in two main parts. In part one there is a theoretical framework. The second part includes methods, design, analysis, results and the conclusion of the four empirical studies. The participants were college students from two different countries who filled out various questionnaires to evaluate the time they spent in viewing soccer sport programming, the meta-perceptions of goal orientation, the moral functioning and aggressiveness. This data was used in the study I in order to adapt and validate two instruments capable to assess these variables. In study II it was observed that meta-perception of ego orientation mediates between the viewing of sport programming about soccer and the moral functioning of spectators. In the study III was determined the influence of gender and the viewing of soccer matches on the aggressiveness and moral functioning of spectators. It was observed that viewing soccer matches had a negative effect on aggressiveness and moral functioning of spectators, especially in males. Finally, the study IV provided evidence supporting that those participants who watched a five minutes video with aggression and violent behaviors images manifested higher levels of physical and verbal aggression and rage than the participants not exposed to such video.

Keywords: education, mass media, sport events

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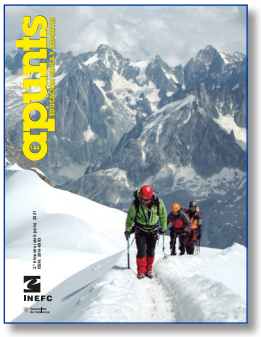

OPEN ACCESS

Profile of the basketball training coach in Andalusia

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Abstract

The main aim of this research is to depict the profile of training coaches (at children and cadet categories) in basketball. A questionnaire was designed for data collection and it was validated by using the technique of expert judges and by employing the Aiken coefficient V for the validation of the instrument. The results of the validation process were adequate being all above 0.7, which was the most demanding minimum standard. In fact, answers from 117 trainers in Andalusia were collected and that led us to conclude that the training basketball coach in Andalusia is a man between 25 and 44 years old who usually trains at a sports club. He usually trains for 3 days a week, during 1.5 hours and participates in a weekly competition. All coaches surveyed had the minimum qualification required to perform the functions as coach.

Keywords: basketball, coaches, questionnaire, training

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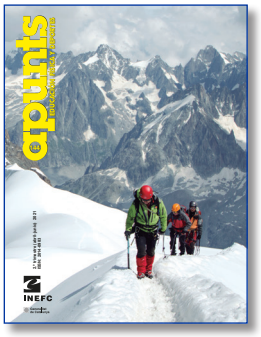

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Longitudinal and Cross-Sectional Study of 3x2 Achievement Goals and Self-Determination in the Physical Education Setting

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Abstract

The main objectives of the seven empirical studies which make up this thesis are: 1) to analyse the evolution of the 3x2 achievement goals model and study the patterns of relationship with outcome variables such as motivational regulations, basic psychological needs and emotional intelligence; 2) to examine the differences with respect to age and gender, and 3) to validate an emotional intelligence questionnaire in the physical education setting. The sample for the cross-sectional studies consisted of 1689 students ($M = 13.25$), while the longitudinal studies involved 282 students ($M = 13.03$). The instruments used were: 3x2 achievement goals questionnaire (3x2 Achievement Goals Questionnaire in Physical Education), friendship goals questionnaire (RGQ-F), perceived locus of causality scale (PLOC), basic psychological needs measurement scale (BPNES), positive and negative affect questionnaire (PANAS-C), satisfaction with life scale (SWLS) and an emotional intelligence questionnaire. The results of the cross-sectional studies show that as age increases all six achievement goals decrease and that males score higher in other-approach goals and task-approach goals. The emotional intelligence questionnaire fits the data well and replicates the three initial factors. The longitudinal studies reveal positive correlations of all 3x2 achievement goals with competence. Similarly, two clusters are included. The first cluster has a high profile on emotional intelligence, intrinsic motivation, identified regulation, introjected regulation, basic psychological needs, friendship goals, positive affect and satisfaction with life. The second shows a low profile in all variables. The final conclusions support a more adaptive pattern of task-approach goals, friendship-approach goals and the three factors of emotional intelligence with respect to motivational, emotional and wellbeing variables. Finally, a number of teaching implications are suggested.

Keywords: achievement goals, emotional intelligence, motivational regulations, physical education

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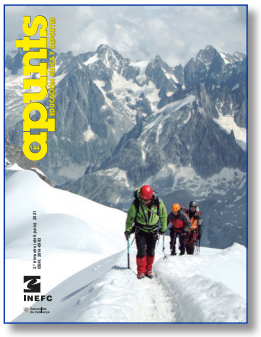

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Effects of the intervention with the Watsu Method on the performance and psycho-social aspects of young Brazilian competition swimmers

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Abstract

This work sought to offer young competition swimmers a moment of relaxation. The Watsu method is performed in the water, wich the same environment in which they perform their sport. *General objective*: to identify and analyze the possible effects of the application of Watsu on young Brazilian swimmers. *Specific objectives*: to know the possible influence on athletic performance, self-efficacy, adherence to training, the willingness to future practice of the method and evaluate the method and application in young swimmers. Twenty-four swimmers between the ages of 13 and 21 of both sexes participated in the study. Among them, 11 individuals formed the experimental group and had Watsu sessions added to the routine for 20 weeks. The other 13 swimmers were the control group and they received no Watsu sessions and continued their usual routines. For the analysis of data, instruments and procedures of a quantitative (e.g., questionnaires and sports results) and qualitative (e.g., interviews and diaries) nature were used. The data were evaluated before starting the intervention, at the end of the intervention and with a follow-up after 17 weeks that corresponded to the end of the competitive year. The quantitative results show no significant changes in relation to athletic performance, self-efficacy and training assistance. However, qualitative data show that the intervention had a positive effect on the swimmers regarding the performance, specific self-efficacy, disposition to the trainings and a desire to continue doing Watsu. Finally, regarding the evaluation of the method and the intervention, the results showed that the method was a valid and necessary experience for the swimmers who perceived physical and psychological benefits inside and outside the sports environment. In short, the results indicate that the method can be an effective way of relaxation, rest and body awareness for young competition swimmers.

Keywords: athlete, relaxation techniques, sport, swimming, training, Watsu, wellness

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