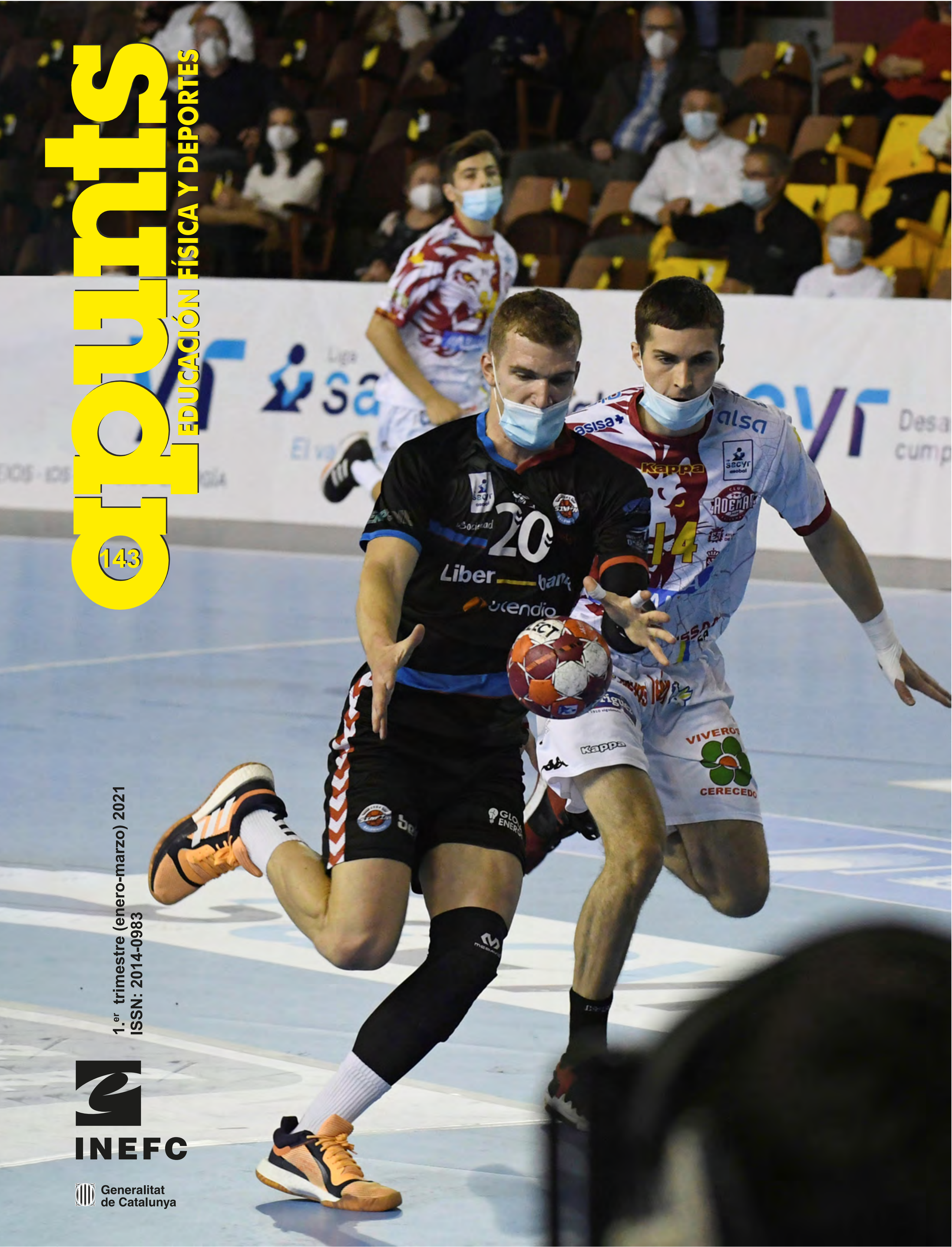


apunts

EDUCACIÓN FÍSICA Y DEPORTES

143

1.er trimestre (enero-marzo) 2021
ISSN: 2014-0983

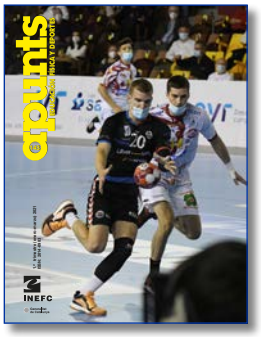
INEFC

Generalitat de Catalunya

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.01



OPEN ACCESS

Level of Physical Condition and Practice of Physical Activity in Adolescent Schoolchildren

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Cite this article:
Moral-García, J.E., Arroyo-Del Bosque, R. & Jiménez-Eguizábal, A. (2021). Level of physical condition and practice of physical activity in adolescent schoolchildren. *Apunts. Educación Física y Deportes*, *143*, 1-8. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.01

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Physical Activity and Health

Original language:
Spanish

Received:
20 February de 2020

Accepted:
7 July 2020

Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

The objective of the study was to ascertain the level of physical condition of adolescents and its association with the practice of physical activity, gender and age. A total of 214 Compulsory Secondary Education students aged between 13 and 16 years participated. The instrument used to ascertain the level of weekly physical activity was the Adolescent Physical Activity Measure-MVPA, whereas the different physical tests contained in the ALPHA-Fitness® battery were used for physical condition. The results show that males do more physical activity and have a better physical condition than females. The physical condition of active adolescents is superior to that of sedentary ones. Physical condition evolves according to age. These results underline the need to develop social programmes to promote physical and sports activity in order to improve people's physical condition and health.

Keywords: activity, school, ALPHA battery, body composition, adolescence.

Introduction

Adolescence is a stage in life involving major physical, psychological and psychosocial changes and is a difficult period to negotiate. It involves the acquisition of healthy lifestyles (Mora, 2014), such as a physically active life, in which the subject can acquire a suitable level of physical condition (PC) and healthy eating habits which are major determinants of present and future health (Ruiz et al., 2009).

In recent years, different research works have reported a substantial reduction in PC levels in children and adolescents alike (Rosa-Guillamón et al., 2016). This situation is relevant because the available scientific evidence indicates that PC is a factor that is more related to a person's health than physical activity (PA) in itself. In fact, in absolute terms PC is a greater predictor of morbidity and mortality among individuals (Gómez-Cabello et al., 2018), both males and females, and is also regarded as a decisive factor in longevity and health-related quality of life (Gálvez et al., 2015). The basic objective of the recommendations of engaging in PA is to increase the individual's overall PC, the latter defined as a set of assessable physical attributes possessed by people and which are related to the capacity to do PA (Caspersen et al., 1985) and which is not only associated with a reduction in the population's morbidity and mortality but also with an increase in quality of life (Rosa-Guillamón et al., 2016).

At this moment in time, the development of unhealthy behavioural patterns among young people is on the increase (Gálvez et al., 2015). Technological progress fosters a more sedentary lifestyle, whereas and at the same time the extensive and varied offer of food products exposes young consumers to inappropriate nutritional habits which translates into a mounting increase in overweight young Spaniards (Cuenca-García et al., 2011). Recent studies suggest that a low PC index is one of the factors directly associated with being overweight and with obesity in young children and adolescents (Gálvez et al., 2015; Rush et al., 2014). Therefore, taking the strong relationship between obesity and several physiological and psychosocial disorders into account (García-Sánchez et al., 2013) as well as public health, wellbeing and the quality of life of young people (Han et al., 2010), it is necessary to detect overweight or obese subjects and observe whether the relationship between this and their level of PC may be important in avoiding health problems in the medium or long term (Gálvez et al., 2015).

Scientific evidence has demonstrated that this entire process does not begin in adulthood but rather at much earlier ages. Longitudinal studies have shown that the degree of PC and the presence of risk factors such as diseases with onset in adulthood caused by a sedentary lifestyle are directly related to the individual's degree of PC in adolescence (Lavielle-Sotomayor et al., 2014).

The level of PC can be evaluated objectively by means of laboratory and field tests, both of which are the most commonly-used methods in the school setting because they are easy to perform, require few financial resources, do not involve the use of sophisticated technical equipment and the time required to perform them is minimal. For these reasons, and in view of the myriad discussions and debates generated among physical education teachers and investigators, a group of European investigators developed and published the ALPHA-Fitness test battery (Ruíz et al., 2011).

The ALPHA-Fitness test battery was constructed in the course of a four-stage process, all of which are explained in the paper by Ruiz et al. (2011). Following an extensive review of the scientific literature and methodological studies pertaining to the validity, reliability, viability and safety of physical condition tests, the ALPHA group published the evidence-based ALPHA-Fitness battery test. This battery includes the following measurement tests: body weight and body height to calculate BMI; waist circumference and skinfold thickness (triceps and subscapular) to assess body composition; handgrip strength test and standing long jump to assess musculoskeletal fitness, and a 20-m shuttle run test to evaluate performance and estimate aerobic capacity.

Although PC may be impacted by the regular practice of moderate-vigorous PA, currently there is insufficient information to establish a connection between PC and the daily amount of PA done by adolescents. Therefore, the objective of this research was to ascertain the level of PC in adolescents according to handgrip strength (HGS), long jump, speed and endurance to ascertain the possible existence of a relationship between PC and the degree of practice of PA while also taking gender and age into account.

Methodology

Method and participants

A four-month transversal descriptive study was designed during which the data were collected from the 214 students distributed in eight groups/class from a Compulsory Secondary Education (CSE) school participating in the study, with a mean age of 14.26 ± 1.33 years and within a range comprised between 13 and 16 years, 58.9% (n = 126) of whom were males. The sample was selected by means of two-stage proportional cluster sampling (taking the year and the group/class into account), assuming an error of <0.3 with a 95% confidence interval. All the adolescents belonging to the classes selected (two groups/class per school year of CSE) were invited to participate. The adolescents were distributed into a sedentary and an active group. The WHO

(2016) recommendations regarding the daily practice of at least 60 minutes of moderate or vigorous PA were taken into account when classifying the groups. This classification (active or sedentary) was established on the basis of the answers given about their practice of PA in the previous week according to the Adolescent Physical Activity Measure-MVPA questionnaire (Prochaska et al., 2001).

Instruments

Various instruments were used to estimate the level of practice of PA by the participants and their physical condition. Weekly PA was ascertained by means of the original version of the MVPA (Prochaska et al., 2001). This questionnaire consisted of two questions about the number of days of PA carried out a week including at least 60 minutes a day of physical exercise ranging in intensity from moderate to vigorous over the previous seven days and in another typical week. The response scale was the same for both items (from zero to seven days of PA a week). The questionnaire was administered and all the students who in the course of the four months fulfilled the PA practice recommendations according to their group (control: sedentary and experimental: active) were selected.

The physical tests contained in the ALPHA-Fitness® battery (Ruiz et al., 2011) were used to measure the adolescents' physical condition:

a) Cardiovascular fitness was studied with the 20-m shuttle run test. The distance to be covered was measured using a 30-metre Elephant brand measuring tape. The time was measured by means a system of photoelectric cells (Timer Plus Control model) which, connected to a laptop computer (Asus 7072), yielded as a result the total time taken to perform the test. Two measurements were taken (separated by five minutes) from which the average of both measurements was calculated as a final value.

b) Musculoskeletal fitness was analysed using the upper-body HGS test and a standing long jump (lower body). A Baseline® digital hand dynamometer was used for the HGS measurements. Long-jump distance was measured using a 30-metre Elephant brand measuring tape. Two measurements were taken (separated by five minutes) from which the average of both measurements was calculated as a final value.

c) Speed of movement was evaluated by the 4x5 metre shuttle test and time was recorded with a CALESI TF-C300 stopwatch.

d) Body composition was studied by means of BMI (kg/m^2 ratio). The measuring instruments used for weight and height were an Elegant model digital scale by ASIMED® (Barcelona) and a SECA® 214 mobile stadiometer (SECA Ltd., Hamburg) (Ruiz-Ariza et al., 2019), respectively.

Procedure

During the study, monitoring the PA practice recommendations made it possible to classify the adolescents into two groups, one sedentary and the other active. The following general inclusion criteria were applied: authorisation of the school and teaching staff, as well as the written consent of the parents or guardians of the minors involved and voluntary student participation. The exclusion criteria, besides non-fulfilment of the inclusion criteria, were: having any type of disease or injury in the four-month study period and failure to observe the PA practice recommendations established for each group (active and sedentary). The students were issued with a log to record their daily PA in order to facilitate the monitoring of this activity. Specific inclusion criteria in the control group were that each subject should do nothing or do less than 60 minutes a day of moderate to vigorous PA; on the other hand, the experimental group had to do at least 60 minutes of moderate to vigorous PA. The participants were given brief instructions and assured that the confidentiality of the data collected in the study would be safeguarded. Anonymity of the answers provided by the participants was also guaranteed since all data were processed in an encoded database. The participants did not receive any academic or financial compensation for their contribution. The research was conducted in accordance with the ethical guidelines of the current Declaration of Helsinki (Brazil, 2013) and the utmost safety and professional ethics standards for this type of work were observed at all times. The informed consent of the parents or legal guardians of the minors involved in the research was secured. The entire process fulfilled all the parameters established by the Research Ethics Committee, pursuant to the Spanish Organic Law 3/2018 of December 5 on data protection and the guarantee of digital rights, as well as by Law 14/2007 on biomedical research.

Data analysis

A descriptive and frequency analysis (Student's t-test for the continuous variables and Chi-squared test for the categorical variables) was performed to extract the information about the sample characteristics as precisely as possible. An ANOVA was used to obtain correlations and comparisons (reporting the mean, standard deviation and effect size) between the different PC tests and the independent variables used. A linear regression analysis was also performed to verify whether the level of PC (analysed with the different tests) was related to the practice of PA, using the ALPHA Fitness battery tests as dependent variables and the level of PA practice as the independent variable, all adjusted according to the gender and age covariates. The level of significance was regarded as $p<.05$. All the analyses were performed using the Statis-

tical Package for Social Sciences (SPSS, version 20.0 for Windows; SPSS, Inc., Chicago, IL, USA).

Results

The 214 adolescents who comprised the total sample, of which 58.9% ($n=126$) were male, were aged from 13 to 16 years (14.26±1.33 years) and 20.1% ($n=43$) were first-year CSE, 21.5% ($n=46$) second-year, 24.8% ($n=53$) third-year and 33.6% ($n=72$) fourth-year. The average BMI was 19.43 (±3.31), with 87.9% ($n=188$) presenting normal weight, 10.3% ($n=22$) overweight and 1.9% ($n=4$) obesity. The remaining variables and their distribution according to the level of PA practice are detailed in Table 1.

The data extracted from the general descriptive analysis showed that right HGS presented higher average values than left HGS (19.82±7.27 kilos vs. 16.06±5.96 kilos), the long jump average was 163.41±43.36 centimetres, mean speed in the 4x5-m shuttle test was 10.75±1.05 seconds and mean endurance in the Course-Navette test was 5.50±2.66 minutes.

More specifically. the one-way ANOVA yielded significant differences in all the variables analysed according to PA practice levels (sedentary and active). Generally speaking, the active adolescents obtained better values in most of the physical tests compared to their sedentary counterparts. By way of example, these differences were evident related to the level of practice of PA and left HGS (F(2.212)=582,203; $p<.000$) or when endurance was analysed according to PA practice (F(2.212)=39,354; $p<.000$). The other variables and data are presented in Table 2.

To complement this, linear regression analysis was performed to verify whether the level of PC, evaluated by means of the different physical tests (dependent variables), presented any type of connection with the level of practice of PA (independent variable), for which purpose they were all adjusted on the basis of the gender and age covariates.

For example, HGS and the practice of PA presented a significantly positive relationship, indicating that the more active adolescents had greater strength (non-standardised ß=2,306, $p=.011$). Considering that the speed test's ten-

Table 1
Sociodemographic and descriptive analysis according to the level of PA practice.

Variables analysed			Physical activity group				*p*
			Sedentary group		Active group		
Gender	[n (%)]	Male	47	(43.9)	79	(73.8)	.000
	[n (%)]	Female	60	(56.1)	28	(26.2)	
Age	[x̄ (sd)]	Value	14.64	(±1.28)	13.88	(±1.28)	.000
	[n (%)]	13 years	25	(23.4)	46	(43)	
	[n (%)]	14 years	7	(6.5)	27	(25.2)	
	[n (%)]	15 years	51	(47.7)	21	(19.6)	
	[n (%)]	16 years	24	(22.4)	13	(12.1)	
Year	[n (%)]	1st CSE	15	(14)	28	(26.2)	.001
	[n (%)]	2nd CSE	16	(15)	30	(28)	
	[n (%)]	3rd CSE	28	(26.2)	25	(47.2)	
	[n (%)]	4th CSE	48	(44.9)	24	(22.4)	
Weight	[x² (sd)]	Kilos	55.02	(±11.48)	57.50	(±11.30)	.113
Height	[x² (sd)]	Metres	1.66	(±.09)	1.73	(±.09)	.000
BMI*	[x² (sd)]	Value	19.82	(±3.86)	19.05	(±3.31)	.090
Ponderal status	[n (%)]	Normal weight	90	(84.1)	98	(91.6)	.079
	[n (%)]	Overweight	13	(12.1)	9	(8.4)	
	[n (%)]	Obesity	4	(3.7)	0	(0)	

Note. n: sample no.; %: percentage; x̄ (sd): mean (standard deviation); CSE: Compulsory Secondary Education. *BMI: adjusted according to gender and weight, according to the scale by Cole et al. (2000). Ponderal index: it is extracted from the BMI value obtained.

Table 2
Analysis of variance according to hand grip strength, long jump, speed and endurance. Classification by levels of PA practice (active and sedentary).

		Descriptive				One-Way ANOVA					
		N	Mean	SD	SE		Sum of squares	df	Root mean square	F	*p*
Right HGS (kg)	S	107	18.25	6.810	.658	Inter-G	527.551	1	527.551	10.400	.001
	A	107	21.39	7.421	.717	Intra-G	10.753.701	212	50.725		
	Total	214	19.82	7.278	.497	Total	11.281.252	213			
Left HGS (kg)	S	107	17.25	6.332	.612	Inter-G	12.246.797	1	12.246.797	582.203	.000
	A	107	14.86	5.792	.079	Intra-G	4.312.227	212	21.035		
	Total	214	16.05	5.966	.623	Total	16.559.024	213			
Long jump (cm)	S	107	149.20	44.408	4.293	Inter-G	43.241.888	1	43.241.888	25.653	.000
	A	107	177.63	37.407	3.616	Intra-G	357.361.925	212	1.685.669		
	Total	214	163.41	43.368	2.965	Total	400.603.813	213			
Speed (sec.)	S	107	11.18	.930	.090	Inter-G	39.551	1	39.551	42.601	.000
	A	107	10.32	.996	.096	Intra-G	196.822	212	.928		
	Total	214	10.75	1.053	.072	Total	236.374	213			
Endurance (min)	S	107	4.43	2.124	.205	Inter-G	242.916	1	242.916	39.354	.000
	A	107	6.56	2.799	.271	Intra-G	1.308.579	212	6.173		
	Total	214	5.50	2.699	.184	Total	1.551.495	213			

Note. A: active (experimental group); S: sedentary (control group); SD: standard deviation; SE: standard error; df: degrees of freedom; Inter-G: intergroup; Intra-G: intragroup. Right HGS: right-hand grip strength; Left HGS: left-hand grip strength; Long jump: continuous value; Speed: continuous value; Endurance: continuous value.

dency is contrary to the other tests analysed, the negative and significant relationship between speed and level of PA (non-standardised ß = -.552, $p = .000$) and gender (non-standardised ß = -.766, $p = .000$) was thus accounted for, whereby speed tended to be greater (fewer seconds were taken to do the test) in active as opposed to sedentary adolescents and in males as opposed to females. The other related variables, as well as the different values found, can be seen in Table 3.

Finally, an analysis of variance (ANOVA) of the different tests analysed was performed according to gender, age and level of PA, yielding significant differences between HGS and gender ($p = .000$), age ($p = .000$) and PA ($p = .000$); between speed and gender ($p = .000$), age ($p = .023$) and PA ($p = .000$); between endurance and gender ($p = .000$), age ($p = .036$) and PA ($p = .000$); and between explosive strength and gender ($p = .000$) and PA ($p = .000$) (Figure 1).

Discussion

This study presents the practical application of a battery of tests designed to evaluate, in the school setting, the level of health-related PC and weekly PA practice. The assessment instruments proposed in the study were selected on the basis of validity criteria and on the direct influence on the fact that qualities such as aerobic capacity, muscular strength and correct weight status can impact future health (Ruiz-Ariza et al., 2009).

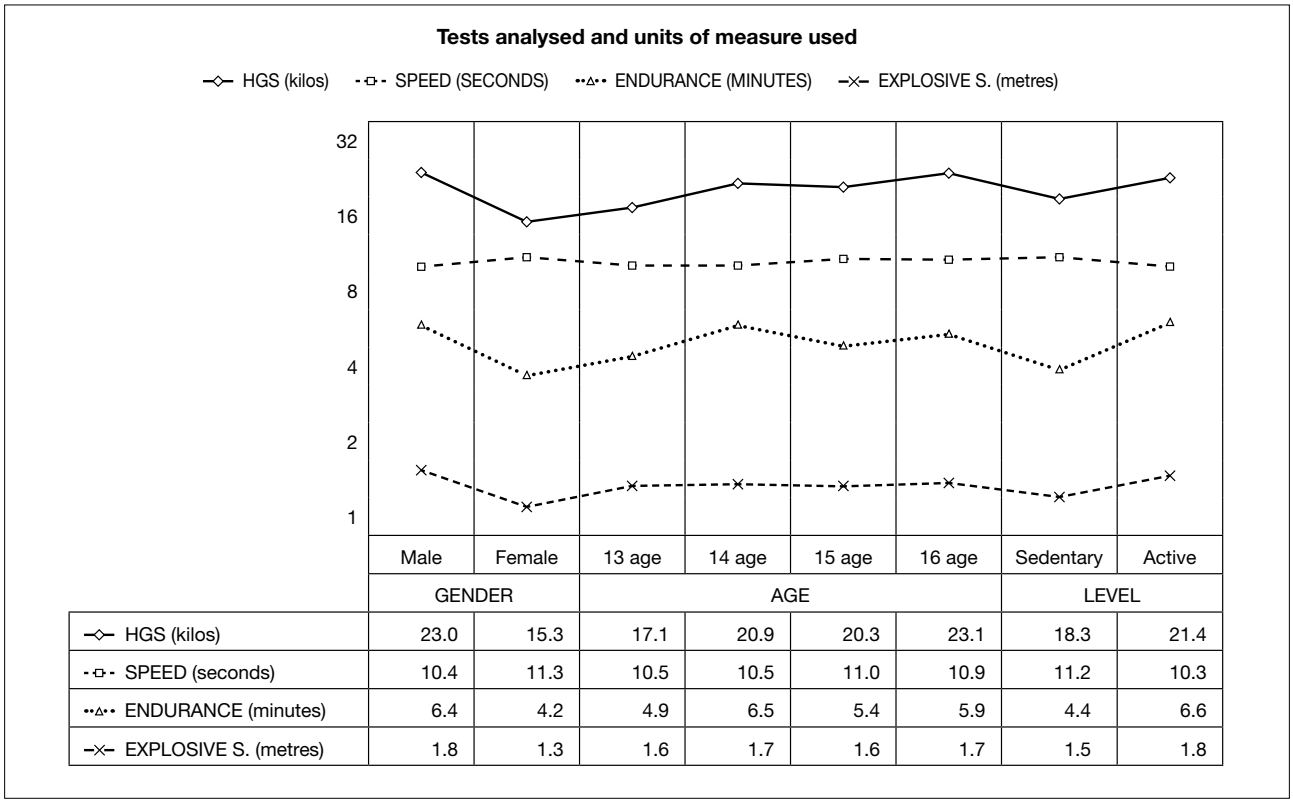
Based on the WHO (2016) BMI classification, this study shows that 84.1% and 91.6% correspond to subjects with normal weight, both in the sedentary and active group, a trend similar to the one found in other papers (Gálvez et al., 2015; Muros et al., 2016). In relation to level of PA practice, a high BMI is significantly associated ($p \leq .001$) with lower levels of PC in the different tests analysed (long jump, 10x5 agility and cardiorespiratory endurance); on the other hand, being overweight is a factor related to an increase in HGS in both hands ($p \leq .001$). This differs from the results obtained by Casajús et al. (2007), since in this study it is the active subjects who present a greater HGS, which coincides with the papers by Mora (2014) and Latorre et al. (2016).

The relationship between PC and the practice of PA yields significant differences in the tests evaluated which are favourable to the active adolescents, as also occurred in the study by López et al. (2016). This study confirms that the active subjects present a better PC (estimated by means of HGS) versus the sedentary subjects, except in the

Table 3
Regression analysis between PC and the level of practice of PA, adjusted with the gender and age covariates.

		Coefficients				ANOVA			
		B	Standard error	t	*p value*	R	df	F	Sig.
HGS (dominant hand)	(Constant)	-3.826	4.034	-.948	.344	.591	3,210	37.636	.000
	PA	2.306	.899	2.565	.011				
	Gender	6.680	.879	7.602	.000				
	Age	1.324	.280	4.726	.000				
Long Jump	(Constant)	117.504	24.329	4.830	.000	.578	3,210	35.089	.000
	PA	16.266	5.420	3.001	.003				
	Gender	43.253	5.299	8.162	.000				
	Age	.878	1.690	.520	.604				
Speed	(Constant)	10.214	-613	16.662	.000	.532	3,210	27.655	.000
	PA	-.552	.137	-4.039	.000				
	Gender	-.766	.134	-5.737	.000				
	Age	.090	.043	2.111	.000				
Endurance	(Constant)	-1.201	1.575	-0762	.447	.528	3,210	27.126	.000
	PA	1.984	.351	5.654	.000				
	Gender	1.502	.343	4.378	.000				
	Age	.344	.109	3.144	.002				

Note. PA: sedentary (0) and active (1); Gender: female (0) and male (1); Age: 13, 14, 15 and 16 years; HGS: hand grip strength; Dominant hand: it is classified depending on the functional predominance of the right or left hand, according to the adolescent's laterality.



	Male	Female	13 age	14 age	15 age	16 age	Sedentary	Active
	GENDER		AGE				LEVEL	
HGS (kilos)	23.0	15.3	17.1	20.9	20.3	23.1	18.3	21.4
SPEED (seconds)	10.4	11.3	10.5	10.5	11.0	10.9	11.2	10.3
ENDURANCE (minutes)	6.4	4.2	4.9	6.5	5.4	5.9	4.4	6.6
EXPLOSIVE S. (metres)	1.8	1.3	1.6	1.7	1.6	1.7	1.5	1.8

Figure 1
Analysis of HGS, speed, endurance and explosive strength according to gender, age and level of physical activity practice.

left-hand HGS test where the sedentary subjects present greater levels of strength, which coincides with the paper by Mayorga et al. (2013). These results concur with those of Torres-Luque et al. (2014).

The analysis of PC related to gender confirms that the level of PA is greater in males compared to females, a tendency that is maintained in all the ALPHA-Fitness battery tests (HGS, long jump, speed-agility and endurance). Considering that doing the speed test faster denotes better physical condition, this accounts for the significantly negative relationship between speed and gender since males did the test in fewer seconds than females, unlike the results of the study by Prieto-Benavides et al. (2015). Also contrasting with this study, García-Sánchez et al. (2013) found that women scored better in the aerobic endurance test (*Course Navette or Multi-Stage Fitness Test*).

These differences in results in terms of gender coincide with previous studies in which males presented better levels of PC in relation to their PA (Torres-Luque et al., 2014; López et al., 2016), as occurs in studies in which PC is related to body composition, diet and physical self-concept (Mora, 2014; Gálvez et al., 2015) or analysing each one of the physical capacities individually (Pacheco-Herrera et al., 2016), in which, as in this study, males present higher values than females in PC. However, when PC is related to variables such as quality of life (Rosa-Guillamón et al., 2016) and/or emotional wellbeing (Rosa et al., 2018), females obtain better scores.

The linear regression analysis suggests that more active adolescents present better values in all the PC analysed, although Cruz and Pino (2004) found that sedentary subjects obtained better values in the HGS test. The tendency means that males have better values than females. Some authors account for these differences favourable to males through the increase in muscle power in relation to body weight, more testosterone than in females and the lower degree of neuromuscular coordination and redistribution of adipose tissue in females (Pacheco-Herrera et al., 2016).

With regard to age, all the PC assessment tests point to a significantly positive relationship favourable to older subjects, who obtain better results in all tests except speed, coinciding with the studies conducted by authors such as Gálvez et al. (2015) and Pacheco-Herrera et al. (2016).

Conclusions

The results of this research show that schoolchildren aged 12 to 16 years with a normal weight have higher levels of PC. These differences are maintained in the by-gender analysis, particularly in all the tests involving the musculoskeletal dimension. According to the scientific evidence obtained, it may be asserted that aerobic capacity and muscle power, as main health indices, could play a protective role against several diseases and also promote better quality of life.

This study has certain limitations. Firstly, PC was evaluated by means of tests taken from a field battery which does not provide the same accuracy as in-laboratory measurements. However, this battery is internationally validated and has been used previously with reliable results in different studies. Secondly, the need for both a broader and more homogeneous sample in terms of gender as well as learning the type of activity performed during the practice of PA and the adolescents' place of residence might also provide a great deal more information. This study could be developed further in the future in the form of a longer-term longitudinal study design.

Nevertheless, it may be concluded that modern-day society needs to promote PA and sports programmes to improve young people's PC and consequently their body weight condition. Increasing the hours of PE in schools and implementing educational programmes targeting healthy life habits could be efficient measures for improving general health.

Acknowledgements

We would like to thank all the sites and participants who were involved in this research as well as the Department of Education Sciences in the Faculty of Education at the University of Burgos, where JE Moral-García did his post-doctoral research stay which forms the basis of this work.

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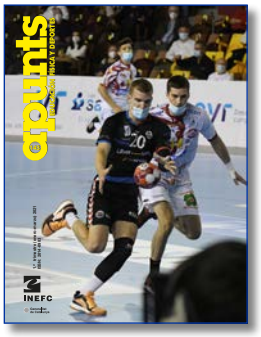
Conflict of Interests: No conflict of interest was reported by the authors.

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.02



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Validation of Oxygen Consumption Prediction Equations and New Formulas for Interval Training

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Cite this article:
Bazuelo-Ruiz, B., De Rosario, H., & Durá-Gil, J.V., (2021). Validation of oxygen consumption prediction equations and new formulas for interval training. *Apunts. Educación Física y Deportes*, *143*, 9-16. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.02

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Physical Activity and Health

Original language:
English

Received:
5 February 2020

Accepted:
8 July 2020

Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

Objectives. Our aims were to determine whether there is any significant difference between the measured and estimated energy expenditure for the most commonly used prediction equations in the literature, and to develop a new specific prediction equation for aerobic interval training with a broader cross-section of the population in terms of age, fitness and body mass index (BMI). *Methods.* Twenty healthy participants were recruited for this study. Two groups of ten people were established depending on their BMI. The low BMI group ranged between 19 and 22, and the high BMI group between 26 and 29. The test protocol consisted of 12 individualized intensities, 6 walking and 6 running speeds on a treadmill, measuring both heart rate and energy expenditure. The rest time between intervals ranged between 1 and 2 minutes *Main results.* The measured oxygen consumption was found to be significantly different from those predicted by the walking and running equations selected from the literature. The Léger equation was the best of the tested equations to estimate oxygen consumption for walking and the ACSM formula was the best for running. However, neither was found to be very accurate. *Conclusions.* The prediction equations selected from the literature in this study were not accurate enough to estimate oxygen consumption during aerobic interval training. We propose four new formulas to improve the estimation of the metabolic cost in interval activities in a population with wider characteristics than those found in the literature.

Keywords: energy metabolism, physical activity, aerobic exercise.

Introduction

Estimating metabolic cost during exercise has been studied for a long time due its relevance in individualized exercise prescription. More precise knowledge about individual energy expenditure (EE) is useful for the medical community, sports trainers and individual patients. Walking and running are the most widely recommended physical activities in populations aiming to improve their quality of life. In fact, most EE prediction equations focus on walking and running modalities. Within these modalities, it is still unknown what key factors – such as volume, frequency, intensity and density – are most suitable for each case. Continuous moderate-intensity exercise (CMIE) has been traditionally prescribed by doctors and sports trainers. However, new types of exercise, like aerobic interval training (AIT), have gained popularity because of their adherence to exercise (Currie et al., 2013) and enhanced benefits compared to CMIE (Hwang et al., 2011; Warburton et al., 2005). Interval exercises can be defined as repeated short bouts of work phases followed by short recovery phases. The main benefits detailed in previous studies include improvements in endothelial and mitochondrial function (Wisløff et al., 2007), functional capacity gains (Daussin et al., 2007; Helgerud et al., 2007) and prevention of cardiovascular diseases (Kemi & Wisloff, 2010). These improvements can all result in a better quality of life (Nilsson et al., 2008) and many people can benefit from this kind of exercise, whether healthy participants (Tsukamoto et al., 2016) or patients with heart disease (Rognmo et al., 2004).

The direct determination of EE is expensive, time-consuming and subject to laboratory conditions. On the other hand, a valid alternative is oxygen consumption estimation from prediction equations found in the literature. Most variables measured for this estimation were acceleration parameters (Bouten et al., 1994; Staudenmayer et al., 2009), heart rate (HR) signals (Keytel et al., 2005; Pettitt et al., 2007) or spatio-temporal parameters (Glass et al., 2007; Hall et al., 2004; Loftin et al., 2010). However, a disadvantage of these equations is that the population used in most investigations was very similar, typically young healthy participants. Moreover, all equations were designed for steady-state submaximal exercise.

Therefore, our aims were (i) to determine whether there is any significant difference between the measured and estimated energy expenditure (EE) for the most commonly used prediction equations in the literature, and (ii) to develop a new specific prediction equation for aerobic interval training with a broader cross-section of the population in terms of age, fitness and body mass index (BMI).

Methodology

Participants

Twenty healthy participants (10 males and 10 females) were recruited for this investigation. Two groups of ten people were established depending on their body mass index (BMI). The characteristics of the study participants were the following: *Low BMI* (5 males and 5 females): age 30 ± 9.2 years; body mass 59.17 ± 8.71 kg; height 1.71 ± .13 m; BMI 20.17±.81; *High BMI* (5 males and 5 females): age 40.2 ± 9.3 years; body mass 78.86 ± 13.63 kg; height 1.67 ± .14 m; BMI 28.17 ± 1.17. The low BMI group ranged between 19 and 22 and the high BMI group between 26 to 29. All participants reported that they were free from any cardiac disease or injury that could limit their ability to complete the test. Participants refrained from strenuous exercise for a minimum of 24 hours and refrained from caffeine consumption for at least 6 hours before each testing session. The study protocol adhered to the tenets of the Declaration of Helsinki and received the Ethics Committee approval of the Polytechnic University of Valencia. All participants gave their informed, written consent.

Procedure

The test protocol consisted of 12 individualized intensities, 6 walking and 6 running speeds. These were established as the participants warmed up according to their individual fitness levels. Regarding the walking and running modalities, participants had to report three speeds. For the walking modality, the first was a comfortable walking speed that participants were used to while walking normally, while the second was a speed at which they could walk and run slowly. From this range, it was equally subdivided in 6 parts to get the 6 walking speeds. The maximum walking speed was selected as the lowest running speed (light jogging). The maximum running speed corresponded to the speed at which participants could maintain at least 4 minutes without reaching visible signs of high levels of fatigue. From the lowest and maximum running speeds, this range was equally subdivided to get the 6 running speeds. Having established their individual speeds, all participants performed 12 different speeds in a randomized order. The reason to establish this

number of repetitions or speeds was to analyse if prediction equations worked correctly in different intensities of walking and running, not just one walking or running speed. Each speed lasted 3 minutes and between there was a rest time of 1 minute after walking speeds and 2 minutes after running speeds. Three minutes was enough time to measure stable oxygen consumption (Nieman, 2010). From this time, the last two minutes for each speed were taken into account for energy consumption analysis (Nieman, 2010). Before the warm-up period, the resting heart rate (HR_{rest}) and energy expenditure were measured over a period of 5 minutes in a sitting position.

Material and Instruments

The tests were performed on a calibrated treadmill (HP Cosmos, Mercury, Germany) with a 1% treadmill grade (Jones and Doust, 1996). HR signals were measured by a nECG MINDER (Nuubo, Spain), which was placed on the participant's chest. Energy expenditure was measured by indirect calorimetry, utilizing open circuit spirometry of the Cosmed K4b2 metabolic analyser (Rome, Italy). The gas analyser was calibrated every morning before the commencement of the tests.

Data analysis

Many formulas have been used in the literature to calculate oxygen consumption. We selected the following prediction equations because they are the most frequently used by physiologists and researchers in their studies.

Walking:

EQ1 (Glass et al., 2007): VO_2 (ml/kg/min) = .1 * S 1.8 * S * fractional grade + 3.5; where S is the speed in m/min; fractional grade is in decimal form, 5% grade is.05.

EQ2 (van der Walt & Wyndham, 1973): VO_2 (L/min): .00599 * M + .000366 * M * V^2; where M: body mass (kg), V: velocity (m/s).

EQ3 (Léger & Mercier, 1984): VO_2 (mL/kg/min) = 2.209 + 3.1633 * V; donde V where V: walking speed in km/h.

EQ4 (Pettitt et al., 2007): METS = 6 * HR_{index} - 5; HR_{index} = $HR_{absolute}$ / HR_{rest}

EQ5 (Keytel et al., 2005): EE (kJ/min) = gender * (-55.0969 + .6309 * heart rate + .1988 * weight + .2017 * age) + (1 - gender) * (-20.4022 + .4472 * heart rate – .1263 * weight + .074 * age); where Male = 1, Female = 0; 1 l O_2/min = 20 kJ/min.

Running:

EQ6 (Glass et al., 2007): VO_2 (ml/kg/min) = .2 * S + .9 * S * fractional grade + 3.5; where S is the speed in m/min; fractional grade is in decimal form, 5% grade is .05.

EQ7 (van der Walt & Wyndham, 1973): VO_2 (L/min): -.419 + .03257 * M + .000117 * M * V^2; where M: body mass (kg), V: velocity (m/s).

EQ8 (Léger & Mercier, 1984): VO_2 (mL/kg/min) = 2.209 + 3.1633 * V; where V: running speed in km/h.

EQ9 (Pettitt et al., 2007): METS = 6 * HRindex - 5; HR_{index} = $HR_{absolute}$ / HR_{rest}; 1MET = 3.5 mL/kg/min.

EQ10 (Keytel et al., 2005): EE (kJ/min) = gender * (-55.0969 + .6309 * heart rate + .1988 * weight + .2017 * age) + (1 - gender) * (-20.4022 + .4472 * heart rate - .1263 * weight + .074 * age); where Male=1, Female=0; 1 l O_2/ min = 20 kJ/min.

Before starting the statistical analysis, the results obtained from every equation were converted to ml/Kg/min, in order to unify and be able to compare between them. A paired t-test was performed to calculate the difference and significance within the measured and estimated VO_2 values for each equation used. In order to calculate the magnitude of the error, the absolute values of the differences between estimated and measured values were also taken into account. Statistical significance was set at the .05 level. Different models for walking and running through a multiple linear regression analysis were then generated to improve the accuracy for this population and type of physical activity (interval training). The models were adjusted by HR_{index}, BMI, gender, speed and age. HR_{index} is the mean absolute HR divided by the HR_{rest}.

Results

The speed range (mean ± SD) for the walking modality was .71 ± .12 m·s^{-1} to 1.74 ± .31 m·s^{-1} and 1.74 ± .31 m·s^{-1} to 2.55 ± .67 m·s^{-1} for the running modality was.

The measured VO_2 was found to be significantly different ($p < .05$) from all walking and running prediction equations used for this analysis. For walking, Table I showed that EQ1, EQ2 and EQ4 underestimate the measured VO_2, and EQ3 and EQ5 overestimate the measured VO_2. For running, EQ6, EQ7, EQ8 and EQ9 underestimate the measured VO_2 and EQ10 overestimates the measured VO_2.

We analysed the independent variables that affect the walking and running models and propose two models for each, depending on whether or not the HR signal is used as

an independent variable. The first model obtained was used with all variables (HR_{index}, BMI, gender, speed and age) but BMI (low or high) and gender (male or female) were not significant ($p > .05$), therefore, these variables were excluded in the final models. Table II shows the model coefficients for the walking modality using HR_{index} as an independent variable, while Table III shows the model for the walking modality without HR_{index}. Table IV and Table V show the model coefficients for running with and without HR_{index}, respectively.

The regression models generated allowed for a more accurate prediction equation for both walking and running for this population. Figure I shows that our prediction equations have a lower absolute error (mean ± SD) with respect to the measured VO_2. The absolute differences of our prediction equations for running were 2.60 ± 2.47 mL·kg·min-1 and 2.79 ± 2.40 mL·kg·min-1 when HR signals are included and excluded, respectively. For walking, we improved to an even greater extent the estimation of VO_2 with the absolute differences as 1.44±1.17 mL·kg·min-1 and 1.79 ± 1.52 mL·kg·min-1 when HR signals are included and excluded, respectively.

Table 1
Measured and estimated VO_2 values and difference between measured and estimated for walking (EQ1-EQ5) and running (EQ6-EQ10). Values expressed in mL·kg·min-1 (mean±SD).

	VO_2	Difference Measured-Estimated	Absolute difference	*SEE*	*SEE*	*95 % CI*		*r*	r^2
						Lower limit	*Upper limit*		
Measured Walking	15.68 ± 5.46	-	-						
EQ1	12.18 ± 2.93	3.49 ± 3.12	3.54 ± 3.07	.28	8.16	2.92	4.05	.894	.800
EQ2	6.60 ± 0.40	9.07 ± 5.09	9.07 ± 5.09	.46	5.12	8.15	9.99	.925	.856
EQ3	16.17 ± 4.72	-0.49 ± 2.44	1.95 ± 1.54	.22	44.80	-0.94	-0.05	.894	.800
EQ4	14.10 ± 4.84	1.57 ± 5.05	4.18 ± 3.21	.46	29.30	0.65	2.48	.526	.277
EQ5	23.04 ± 6.46	-7.36 ± 5.25	7.64 ± 4.82	.47	6.51	-8.31	-6.41	.623	.389
Measured Running	31.68 ± 7.53	-	-						
EQ6	30.44 ± 7.12	1.24 ± 3.77	3.13 ± 2.41	.34	27.84	0.55	1.93	.869	.755
EQ7	26.80 ± 1.37	4.88 ± 7.16	7.07 ± 4.97	.65	13.50	3.57	6.18	.351	.123
EQ8	26.67 ± 6.46	5.01 ± 3.72	5.50 ± 2.95	.34	6.84	4.33	5.69	.869	.755
EQ9	24.15 ± 6.72	7.53 ± 8.16	9.44 ± 5.82	.75	9.97	6.04	9.02	.348	.121
EQ10	37.29 ± 9.08	-5.61 ± 7.79	7.32 ± 6.19	.71	12.79	-7.03	-4.18	.574	.329

Table 2
Coefficients and significance for the multiple linear regression model adjusted by age, HR_{index} and walking speed.

	Non-standardized coefficients		Standardized coefficients	t	*p*
	B	Type error	*Beta*		
Constant	13.031	1.942		6.709	<.001
Age (years)	-.068	.018	-.127	-3.750	<.001
Speed^2 (km·h-^{1})	.586	.075	1.521	7.843	<.001
HR_{index}	2.088	.945	.088	2.210	.029
Speed (km·h-^{1})	-2.454	.705	-.671	-3.480	.001

Table 3
Coefficients and significance for the multiple linear regression model adjusted by age and walking speed.

	Non-standardized coefficients		Standardized coefficients	t	*p*
	B	Type error	*Beta*		
Constant	15.227	1.696		8.977	<0001
Age (years)	-.055	.017	-.103	-3.154	.002
Speed^2 (km·h-^{1})	.603	.076	1.565	7.976	.001
Speed (km·h-^{1})	-2.454	.717	-.663	-3.480	<.001

Table 4
Coefficients and significance for the multiple linear regression model adjusted by age, HR_{index} and running speed.

	Non-standardized coefficients		Standardized coefficients	t	*p*
	B	Type error	*Beta*		
Constant	6.415	2.524		2.542	.012
Age (years)	-.087	.039	-.118	-2.202	.030
HR_{index}	3.051	1.211	.130	2.520	.013
Speed (km·h-^{1})	2.877	.202	.781	14.252	<.001

Table 5
Coefficients and significance for the multiple linear regression model adjusted by age and running speed.

	Non-standardized coefficients		Standardized coefficients	t	*p*
	B	Type error	*Beta*		
Constant	9.302	2.300		4.044	<.001
Age (years)	-.047	.037	-.064	-1.272	.206
Speed (km·h-^{1})	3.107	.184	.843	16.855	<.001

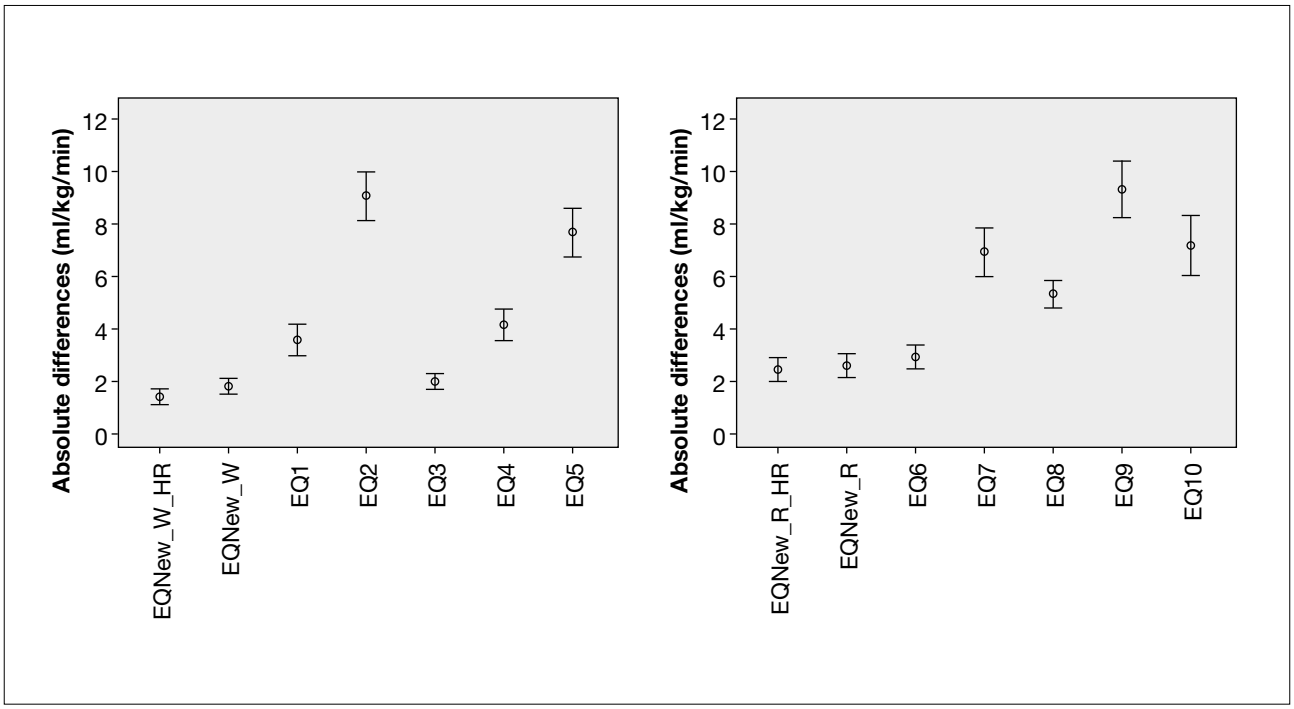

Figure 1
Comparison of the absolute differences for walking (left) and running (right). Values reported in mean±SD.

Discussion

This study focused on measuring oxygen consumption during aerobic interval training in a population with different energetic demands and BMI values. First, we compared the accuracy of the measured and estimated O_2 consumption for AIT. Then, if this was found to be not accurate enough, we proposed four new formulas to improve the estimation of metabolic cost in interval activities in a population with more varied characteristics than previously found in the literature.

The sample used in most studies is young, healthy and of normal weight, with a BMI lower than 25 (Glass et al., 2007). The sample tested consisted of participants with different characteristics that had not been previously tested. The sample of Hall et al. (2004) was different. They recruited a total of 24 participants with a BMI ranging from 20 to 27.4; however the mean BMI for women and men was 22.37 and 23.64, respectively. Another difference with our study is the mean age, being 21.4 and 23.2 years for women and men respectively in their study. Otherwise, Loftin et al. (2010) developed a prediction equation for a population similar to our own but the EE estimation was for a given distance (1 mile) rather than for a given time or speed, which is usually used in interval training.

The specificity of the activity employed for measuring oxygen consumption in the training activity is relevant if accuracy is being sought. ACSM´s equations (Glass et al., 2007) are frequently used in the literature by physiologists and trainers, though they have some limitations. They were designed for steady-state exercises and are dependent upon speed range (.83 to 1.66 m·s-1 in the walking equation and greater than 2.22 m·s-1 in the running equation). There is therefore a gap missing for the 1.66 to 2.22 m·s-1 speed range. Moreover, some studies (Hall et al., 2004; Koutlianos et al., 2013; Loftin et al., 2010; Peterson et al., 2003) have cross-validated ACSM´s prediction equations and concluded that they are not capable of accurately predicting O_2 consumption. This is due to the application of these formulas to different protocols or exercise modalities.

Weyand et al. (2013) found that the ACSM prediction equation for walking significantly underestimated the metabolic rate. Our results agreed with this study but indicated that EQ3 was the best of the tested equations to estimate O_2 consumption in the walking modality and EQ6 was the best for the running modality. However, neither is accurate enough ($p < .05$) when compared with measured values. For running, the worst prediction equations were those using HR signals as input to estimate metabolic cost.

The EE in walking and running are different, being higher for the latter. We also determined that the EE in the running modality was higher than in the walking modality for the same absolute speed. Therefore, as noted in other investigations (Glass et al., 2007; van der Walt & Wyndham,

1973) it was necessary to design separate equations for walking and running.

To the best of our knowledge, there are no equations that can accurately predict O_2 consumption for AIT in a population with different BMI values. Therefore, we developed two prediction equations for walking and two for running, including age (years), speed (in km/h) and HR_{index}($HR_{absolute}$ / HR_{rest}):

Walking:

EQNew_W_HR (ml/kg/min) = 13.031 – .068 * Age + .586 * $Speed^2$ + 2.088 * HR_{index} – 2.454 * Speed

EQNew_W (ml/kg/min) = 15.227 – .055 * Age + .603 * $Speed^2$ - 2.425 * Speed

Running:

EQNew_R_HR (ml/kg/min) = 6.415 – .087 * Age + 3.051 * HRindex + 2.877 * Speed

EQNew_R (ml/kg/min) = 9.302 – .047 * Age + 3.107 * Speed

We found that the inclusion of HR_{index} to estimate VO_2 consumption resulted in greater accuracy. However, for a given exercise intensity, as ambient temperature increases, HR also increases, with little or no corresponding increase in EE (Hebestreit & Bar-Or, 1998).

Conclusions

The prediction equations selected from the literature in this study were not accurate enough to estimate oxygen consumption during aerobic interval training. We propose four new formulas to improve the estimation of the metabolic cost in interval activities in a population with wider characteristics than those found in the literature. From a practical perspective, in real conditions the equations should be used with caution. Additionally, the proposed equations can be used to estimate oxygen consumption in aerobic interval activities, such as walking or running, although we caution that these formulas have not been cross-validated. Further studies should validate them.

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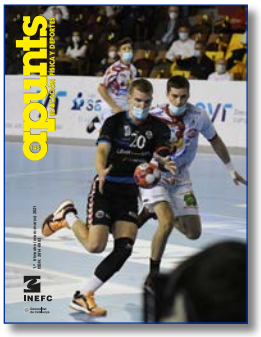
Conflict of Interests: No conflict of interest was reported by the authors.

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.03



Physical Education and Inclusion: a Bibliometric Study

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Cite this article:
Marín-Suelves, D., & Ramón-Llin, J. (2021). Physical Education and Inclusion: a Bibliometric Study. *Apunts. Educación Física y Deportes*, *143*, 17-26. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.03

OPEN ACCESS

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Physical Education

IOriginal language:
Spanish

Received:
17 February 2020
Accepted:
10 July 2020
Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

The possibilities offered by the Physical Education (PE) subject in the educational setting are extensive and go well beyond the mere development of basic motor skills. Our society and schools are diverse and pursue sustainable development goals in which inclusion is a core factor in ensuring quality education. For this reason, the general objectives of this paper were to perform a bibliometric study about inclusion in PE and also to conduct content analysis. The bibliometric analysis studied the production, collaboration and impact of the publications. The content analysis studied the keywords used, methodological aspects, the contribution made by PE and the results. The search was performed in the *Scopus* database which yielded a total of 103 articles. The results in terms of output point to a major increase in the presence of scientific publications in journals in the social sciences over the last 10 years, mainly from countries such as the USA, Brazil and Spain. Most of these studies are collaborative, there being only one author working alone as a major producer. However, their impact quantified in terms of citations was scant. The content analysis revealed a majority of non-interventional studies with a predominance of qualitative methodologies in order to improve the competencies of students with special educational needs (SEN) and attitudes towards them in the primary and secondary stages. Generally speaking, adapted games from the games and sports block were used as PE resources to promote inclusion.

Keywords: school, sports, inclusion, bibliometrics.

Introduction

Inclusion has become an issue of global interest in the social policies of many countries, beginning with the initial attempts at the integration of students with disabilities in the last century through to the pursuit of the highest possible personal development of students with Specific Needs of Educational Support (SNES) in a minimally restrictive setting. In 2015, the United Nations General Assembly approved the 2030 Agenda featuring the Sustainable Development Goals (SDGs). The fourth goal of a total of 17 referred to quality education and focused on inclusion. More specifically, its objective was: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (page 3). In turn and in order to accomplish this quality education goal, 10 targets were established, one of which pertained to the issue of "gender equality and inclusion". As acknowledged, the aim was to "…ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations" (UNESCO, 2016, page 4).

In Spain, Rubio (2017) analysed the evolution of inclusion from the early attempts at providing care for students with a disability in the Moyano Law of 1857, via the establishment of disaggregated special education in the General Law of 1970 and on to the integration of special education in the single educational system as of the Organic Law on general organisation of the educational system (LOGSE, 1990). Currently, the Organic Law for the improvement of educational quality (LOMCE, 2013), in line with the proposals of the Organic Law on education (LOE, 2006), established that the governing principle of education is inclusion. As of this point, SNES are taken to include: students with special educational needs (SEN), those who join the educational system late, those with learning difficulties, those who come from disadvantaged social backgrounds, students with attention deficit hyperactivity disorder (ADHD) and high-ability (HA) students.

Likewise, PE is a subject that is included in the curriculum for the purpose of developing motor skills and promoting hygiene and health by creating habits. According to Arnold (1991), PE is a subject of interest to the educational setting due to the three educational dimensions of the activities that require movement. These three dimensions refer to learnings that can be obtained when aspects "about" activities that require movement are studied, in other words, theoretical knowledge, such as ways of working on muscle strength or aerobic endurance; activities that are learnt during or begin "in" the performance of physical activities, in other words practical knowledge, such as taking the right decision under certain conditions of play, and finally learnings produced "through" activities that require movement, for example, the social values of self-improvement, respect and also other types of interdisciplinary knowledge.

From this standpoint, PE's possibilities for achieving inclusion would seem to be evident. In this regard, Mosston and Ashworth (1993) established a spectrum of teaching styles in PE associated with three teaching techniques depending on the students' degree of autonomy. In descending degrees of autonomy, they are student design, discovery and direct teaching by teaching staff. This last technique straddles five teaching styles, particularly the inclusion style which says there are different levels of execution of the same task (Molina, 1999), thus enabling everyone to participate and learn since all students receive a bespoke proposal in order to be able to work according to their needs.

Many publications have addressed the inclusion of students with SNES in recent years along with the opportunities offered by physical activity, sports and leisure time (Lizcano et al., 2018) in accomplishing this goal. Two general objectives were set. The first was to perform a bibliometric study about the inclusion of PE, and three specific objectives were defined to analyse production, collaborations and co-authorship and the repercussion or impact of the research. The second objective consisted of exploring the studies further, for which purpose four specific objectives were set: analyses of the keywords used, methodological variables, the influence of PE and the study's results.

Methodology

Bibliometrics provides quantifiable data about scientific activity pertaining to an object of study (Tomás-Gorriz & Tomás-Casterá, 2018), in this case PE's possibilities for achieving the inclusion of students with SNES and the impact of these publications. The *Scopus* database was used as it is seen as the most comprehensive in terms of time coverage, the number of documents available by area (Hernández et al., 2016) and on account of its acknowledged prestige in the scientific domain.

The study involved five phases. The first phase consisted of establishing the search equation and the following keywords were used: "physical education" AND inclusion AND disability OR "special educational needs" AND school.

The second phase involved the selection of the documents that would ultimately be included in the study following an initial reading of the abstracts. The decision was taken not to apply any time filter, whereby results were

Table 1
Indicators for the document content analysis.

Methodological elements	Participants	0. Unspecified students 1. Non-university education students 2. University education students 3. Teaching staff 4. Parents/guardians 5. Specialists 6. Students with SNES
	Type of school	1. Specific school 2. Ordinary school
	Educational stage	1. Preschool 2. Primary 3. Secondary 4. Pre-university 5. Higher
	Specific need for educational support	1. SEN 2. ADHD 3. Specific learning difficulties 4. HA 5. Personal conditions or family history 6. Late joining the educational system
PE	Type of work	1. Review article 2. Instrument validation 3. Trial 4. Intervention analysis 5. Book or chapter
	PE content block	1. Body schema and autonomy 2. Motor skills 3. Expressive skills 4. Physical fitness and health 5. Games and sport 6. Activities in the natural setting
	Types of Physical Activity	1. Aerobic 2. Anaerobic 3. Mixed adapted games 4. Paralympic programme 5. Non-adapted sports skills
Results	Results	1. Competencies 2. Learnings 3. Education in values 4. Student motivation 5. Attitudes, perceptions or beliefs 6. Respect for and appreciation of diversity 7. Inclusion 8. Self-concept or self-efficacy 9. Curriculum design

Source: own compilation.

obtained from 1993 to 2019 through the analysis of the documents published in the last 25 years. According to Bordons and Zulueta (1999), analysing the output in an entire scientific area is interesting, although an analysis of the areas of study from which the question is being addressed was deemed useful. Of the 109 documents emerging from the search, reading the title and the abstract of each one led to six being ruled out for not fulfilling the study's objectives, leaving a total of 103 documents for the analysis. The third phase involved the analysis of the data based on the preparation and completion of a data record with the key information from each of the documents selected. The fourth phase consisted of considering the emergence of findings. The last phase involved the analysis of content depending on the most frequent words and the relationships between them, as well as a review of the key elements of each of the documents, allowing us to explore the relationship between PE and inclusion on a deeper level.

Data analysis

The bibliometric analysis was performed on the basis of the indicators established by Aleixandre (2010), distinguishing between the indicators of production, collaboration, and repercussion and impact. For the output study, the publications were analysed according to: areas of knowledge, articles published per year, type of documents, by-country productivity, publication language, higher education institutions and the most outstanding journals. Collaboration in the publications was analysed depending on the number of authors and by-author productivity. Finally, the repercussion and impact of the publications was analysed based on the number of citations received.

Furthermore, the content analysis studied the keywords, methodological aspects, results and the influence of PE. With regard to the keywords, the terms used, their frequency and co-occurrence were analysed. The methodological aspects analysed were the sample, type of school, educational stage, type of SNES and finally type of work. The contribution of PE was analysed on the basis of content blocks (LOMCE, 2013) and the type of physical activity performed. Finally, the results obtained were analysed. A data record was drawn up showing the variables regarded as relevant by two researchers as well as the categories included by each one of them, yielding a total of eight variables (Table 1).

A Cohen's Kappa test was performed to analyse the inter-subject reliability of the coding of the content variables for each variable from 10% of the texts selected at random, resulting in scores above 0.967 for all of them which is regarded as a very high level of agreement (Altman, 1991, p. 404). Finally, VOSviewer (Van Eck & Waltman, 2011) was used to build and display the co-occurrence maps graphically and WordArt tools for building the word clouds.

Results

This section is divided into two analyses: the bibliometric analysis and the analysis of the content of the documents selected for the study.

Bibliometric analysis

Production analysis

With regard to the areas of knowledge addressing this topic, the social sciences (34.2%) and the health sciences (29%) were particularly predominant over other areas such as medicine (18.7%), psychology (10.9%) and the arts (2.6%). In terms of scientific productivity based on the data for the number of articles published, the results obtained in the last decade warrant particular mention (Figure 1). This analysis allows us to ascertain the frequency of publication on this topic, the evolution of interest in the subject studied and the general trend over time. Of the 103 documents published between 1993 and 2019, the number of publications has grown in recent years, particularly since 2009 which accounts for 84% of the output analysed.

With regard to type of documents, the majority (93.2%) are articles. There are major differences in each country's bibliometric size, the largest being the USA with 36 texts (35%), Brazil with 18 articles (17%), followed by Spain with 14 documents (14%) and the United Kingdom with 11%. Therefore, the leading countries in this field come from both the American and European continents, although this topic is addressed from different geographic areas as can be seen in Figure 2, which shows the countries with more than one publication in the field of inclusion based on PE.

In terms of publication language, and as occurs in other bibliometric studies, the bulk are published in English (81%) with a low number of publications in Portuguese (12%) and in Spanish (9%). In this case, there are also documents in languages that are somewhat infrequent in other research conducted from this same standpoint such as Croatian or Lithuanian, each of which accounts for 1% of the total.

The higher education institutions with the greatest number of publications abroad are the University of Virginia (Hodge et al., 2017) and Ohio State University (Haegele & Zhu, 2017). In the Spanish setting, the main producers are Miguel Hernández University (Reina et al., 2019), the

University of Castilla la Mancha (Abellán et al., 2018), the University of Santiago de Compostela (Varela et al., 2019), the Polytechnic University of Madrid (Ocete et al., 2017) and the University of Valencia (Moya-Mata et al., 2017).

Moreover, the most prominent journals include *Adapted Physical Activity Quarterly, Physical Education and Sport Pedagogy, the Revista Brasileira de Educação Especial and Sport, Education and Society.*

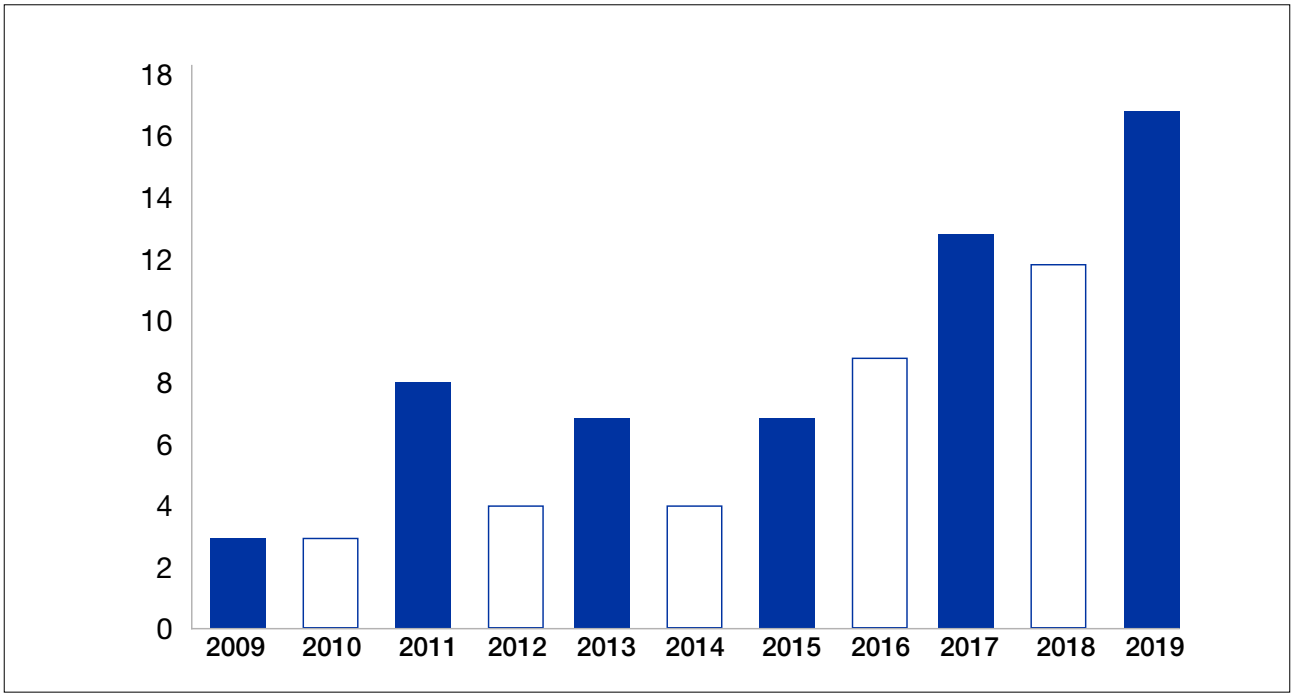

Figure 1 *Number of articles per year.*
Source: own compilation from information from Scopus.

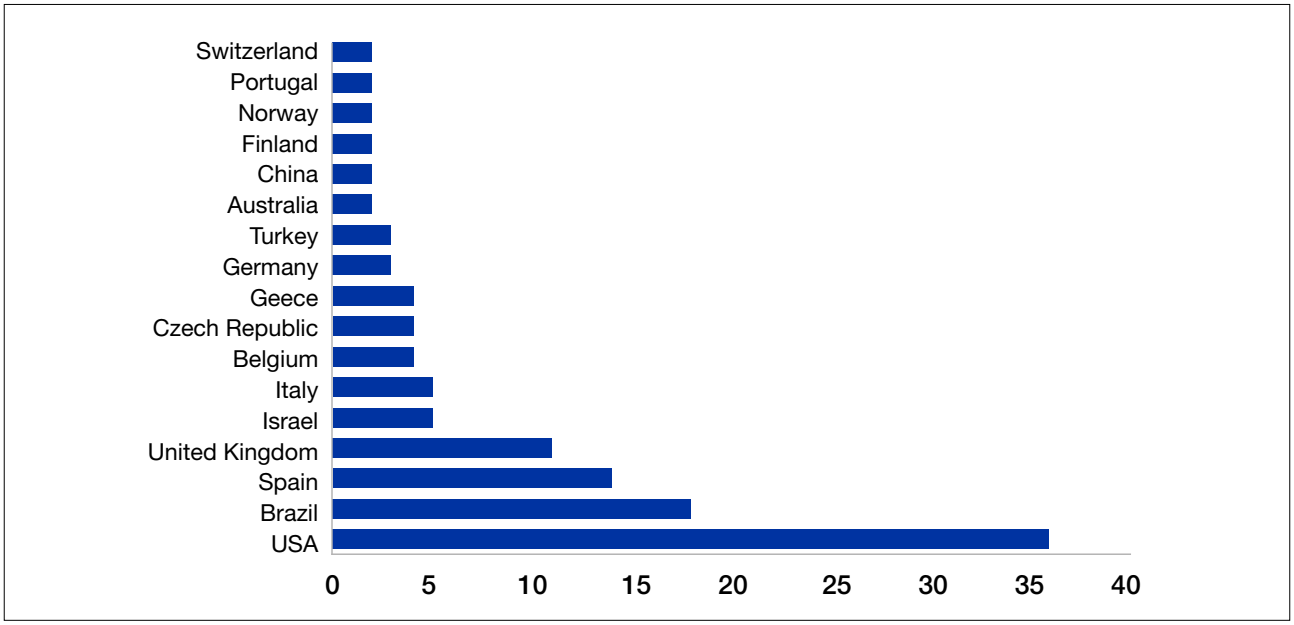

Figure 2 *Number of publications per country.*
Source: own compilation from information from Scopus.

Collaboration analysis

In terms of collaboration and co-authorship, a total of 160 authors were involved in the 103 documents selected, meaning that the index of collaboration in this field is high. Table 2 shows the results of the number of co-authorships per document, making it possible to identify the collaboration networks generated in the scientific community with regard to the PE-Inclusion pair.

As can be seen, 87% of the scientific output was written on a collaborative basis. Of the total, 36% was written by more than three authors; here particular mention may be made of Alves et al. (2017), who analysed teaching staff's perception of the concept of inclusion and the benefits and drawbacks encountered in the implementation of inclusion in their classrooms, with a total of eight authorships.

Turning to the number of works involving the same author, for which purpose Lotka's law of scientific productivity was used, there was a predominance of occasional producers (96%) with one, two or three texts per author, medium-sized producers (2.5%) and only one large producer (0.6%), Martin E. Block (Table 3).

Table 2
Collaboration and numbers of authorships.

Number of authorships	*n*	%
One	13	13 %
Two	20	19 %
Three	34	33 %
Four	17	17 %
Five	10	10 %
More than five	9	9 %

Source: own compilation.

Table 3
Distribution of production.

No. of documents	Authors-hips	% n=	Lotka
1	123	76.9 %	Occasional producers
2	28	17.5 %	Occasional producers
3	3	1.9 %	Occasional producers
4	1	0.6 %	Medium-sized producers
5	1	0.6 %	Medium-sized producers
6	2	1.2 %	Medium-sized producers
13	1	0.6 %	Large producer

Source: own compilation.

Analysis of the repercussion or impact of the research

In terms of the impact of the documents analysed, measured by means of the number of citations received (Table 4), it transpires that almost one third of the publications had no citations, one third had between one and five citations and 15% had between six and 10, thus reflecting the low impact of most of the research, which may also be accounted for by the fact that many of these publications are recent. Nevertheless, there are 12 articles with more than 100 citations, such as the one by Morley et al. (2005) which addresses the question of the inclusion of students with SEN from the standpoint of the secondary school teacher.

Table 4
Number of citations received.

Citations	*n*	%
None	29	28 %
1 – 5	33	32 %
6 – 10	15	15 %
11 – 15	8	8 %
16 – 20	6	6 %
More than 20	12	12 %

Source: own compilation.

Content analysis

With regard to the content of the 103 documents, the keywords, methodological aspects, the influence of PE and results were analysed. In order to analyse the methodological aspects, the influence of PE and the results, categories were established before the documents were read by two researchers independently so as to subsequently, and following an initial reading of these documents, reach a consensus on the categories that would ultimately be included in the analysis (Table 1).

Analysis of the keywords

First of all, the keywords were identified, amounting to a total of 160 different words. Figure 3 shows these words and their weight in the documents analysed. The high degree of confidence of the words used by the research teams is noteworthy.

Secondly, Table 5 presents the terms used most frequently.

Finally, Figure 4 shows the map of co-occurrence of the keywords that reflects the relationships between the terms and their tendency to appear together. Three clusters

Figure 3 *Most frequent keywords.*
Source: own compilation with WordArt.

Table 5
Most frequent keywords.

Keyword	N	*% n = 137*
Physical Education	65	47 %
Inclusion	45	33 %
Disability	30	22 %
Special Educational Needs	15	11 %
Attitudes	10	7 %
Physical Education and training	9	6.5 %
Special Educational	8	5.8 %
Sport	8	5.8 %
Integration	7	5 %
Intellectual Disability	7	5 %

Source: own compilation based on VOSviewer data.

may be distinguished. The main one is comprised of 12 terms such as disability, education, handicap and teaching. The second cluster includes 11 words such as inclusive education, learning difficulties, educational support, primary education, professional development, teaching staff and SEN. Finally, the third cluster includes five terms such as attitudes, integration and school. Therefore the context, subject, actors concerned and perceived benefits are represented.

Analysis of the methodological aspects

Major diversity was observed in the type of research and, in ascending order of frequency, review studies (4.9%), instrument validations (9.7%) (Haegele, 2019) and intervention descriptions (17.4%) were obtained. In the studies in which no interventions were performed there was a predominance of quantitative (37.9%) over quantitative (19.4%) methodologies. As for the stages in each research document, it is telling that most of the studies focused on the primary (26.2%) and secondary (28.2%) stages.

With regard to the SNES presented by the participants, it is noteworthy that the participants had SEN in 78.6% of the documents. In terms of the type of schools, a small percentage of the studies (2%) was conducted in special education schools versus a majority in conventional schools (62.1%).

Analysis of the contribution of PE

Content block could only be ascertained in 3% of the articles, all of which referred to games and sports. Of the studies, 67% stated that they had been performed in the secondary stage using a qualitative methodology based on interviews with specialised staff. The results indicated contributions for improving learning, competencies and self-concept as well as respect for and appreciation of people with SNES.

Physical activity was only extracted in 12% of the articles, in which 8% of the type of physical activity performed was aerobic for pre-university students with SEN. An intervention was performed leading to improvements in students' motivation for PE.

Likewise, 67% of the studies used mixed adapted games or exercises. Of these studies, 63% analysed primary and secondary students in equal proportions. Moreover, 75% of the studies involved students with SEN, with qualitative research (50%) predominating slightly over quantitative research (38%). The results indicated contributions for improving learning, competencies and self-concept, albeit with greater incidence on respect for and appreciation of people with SEN.

Furthermore, a Paralympic programme was conducted with primary students in 12% of the studies. An intervention was performed and the results indicated greater respect for and appreciation of students with SEN. Finally, 17% of the studies were conducted half and half in primary and secondary education by giving questionnaires to the students. The results indicated greater learning and competence as well as an increase in respect for and appreciation of students with SNES.

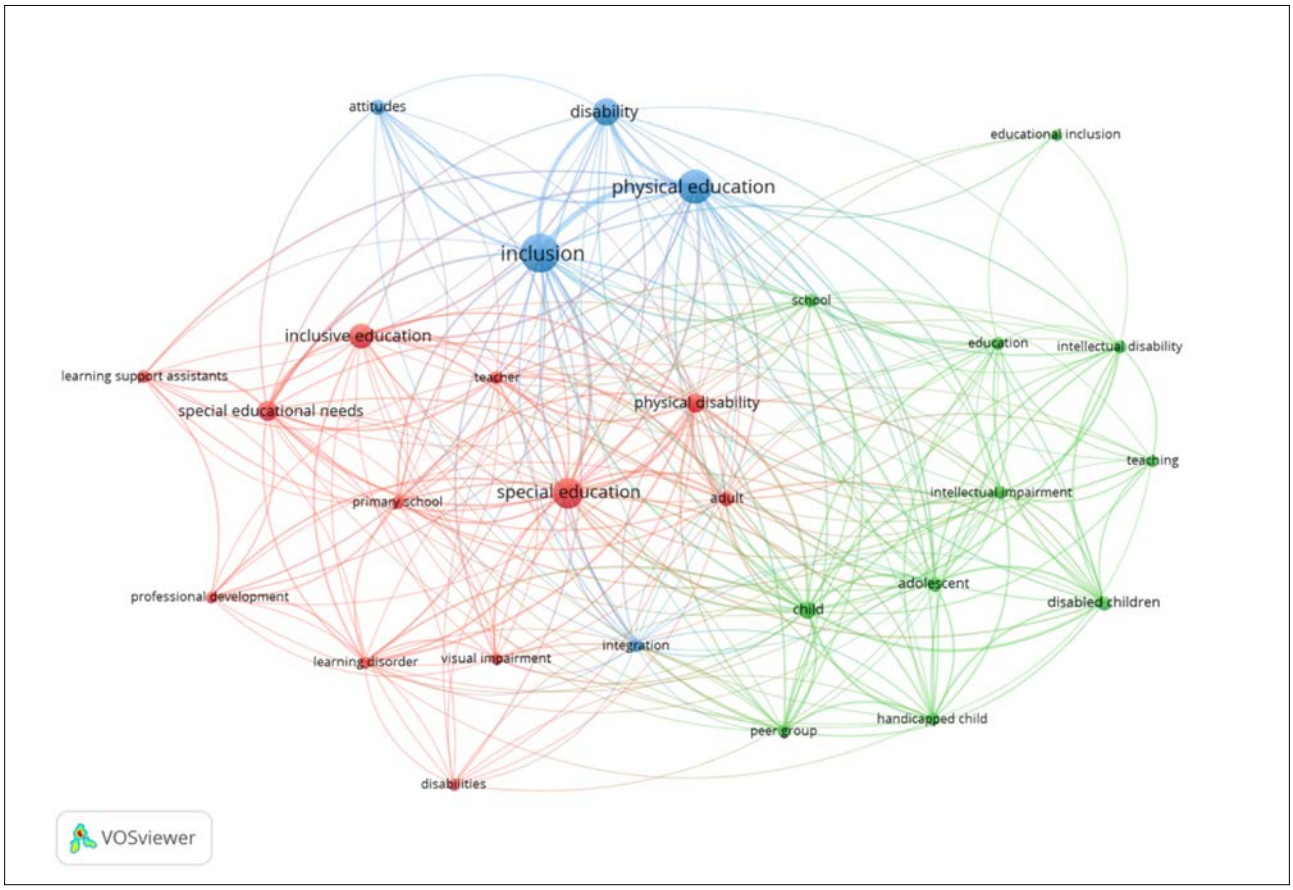

Figure 4 *Term co-occurrence map.*
Source: VOSviewer.

Analysis of the results obtained

Finally, and in terms of results, most of the studies focused on studying inclusion strategies (68.9%); in second place analysing the attitudes, perceptions or beliefs of students and teaching staff with respect to students with SEN (38.8%); and thirdly the results focused on the improvement of competencies (26.2%) and learnings (31%) of both teaching staff and students. One out of every 5 articles addressed respect for and appreciation of diversity, and one in every 10 analysed the improvement of self-concept. Curriculum design (6.7%), education in values (3.8%) and student motivation (2.9%) were the least addressed results. Of all the texts analysed, the studies by Haycock and Smith (2010) and Morley et al. (2005) obtained the most extensive results.

Discussion

The primary objective of this paper was to perform a bibliometric study about inclusion in PE. The bibliometric analysis was structured into three specific objectives in order to study output, collaboration and impact in the studies. In terms of output, the social sciences enjoyed particular prominence, coinciding with the results of Sola-Martínez et al. (2020) in a study on teacher training and educational quality. There was continuous growth with output increasing in the last decade, as also noted by González-Zamar and Abad-Segura (2020) in their research about the university educational setting. Countries such as the USA, Brazil and Spain, and therefore English, Portuguese and Spanish, stood out as they did in other recent studies (Abad-Segura et al., 2020; Hinojo et al., 2019).

Moreover, the degree of collaboration was high, as was also observed in the study about gamification (Peirats et al., 2019), and most of the authors were occasional, as in the study by Cabrera (2020). The Lotka index was used, yielding similar findings to those obtained in a study about motivation in the educational setting (Campos et al., 2020). Finally, impact as evaluated by means of the number of citations received was low, coinciding with other bibliometric studies in the area of sports (Blanca-Torres et al., 2019).

The second objective consisted of analysing content in terms of keywords, methodological aspects, the subject of PE and the results obtained. The main keywords were *physical education, inclusion and disability* which coincide with the search terms, as is also the case in other bibliometric studies (Moreno, 2019). Methodologically, there were more studies in the primary and second stage, perhaps because of the greater availability of teaching staff for research purposes, and the main protagonists (participants) were students with SEN, denoting implementation of the SDGs (2030). Qualitative methodologies prevailed, probably due to the ease of holding interviews with teaching staff and specialists as compared to the authorisations required to administer questionnaires to students. The analysis of the influence of PE pointed to a greater use of adapted games, probably because games are the content in this subject that most motivates students in general (Castro et al., 2006). Finally, the results of the studies contributed improvements for inclusion strategies (Marques et al., 2013), attitudes towards students with SEN (Hernández et al., 2011; Nieva & Lleixà, 2018) and the improvement of their competencies and learnings, the objectives of most of the studies.

The main limitations are the scant percentage of papers that provide information about the type of physical activity performed or the PE content block.

With regard to future research lines, further work is called for on the differences between contents in this area that are particularly conducive to or may hamper inclusion, and also scheduling based on universal design for learning (UDL) and its application to the different educational stages. In this respect, the level of inclusion should be compared according to the use of games and sports with a competitive as opposed to a cooperative approach, as well as other PE content blocks.

Conclusions

The main conclusions of this study are that the social sciences are the predominant area of research and that most output has been produced in the last ten years, particularly in countries such as the USA, Brazil and Spain. Most of the articles were written in collaboration, although major producers were somewhat scarce and most of the research had a relatively low impact.

The content analysis revealed a predominance of qualitative studies focusing on students with SEN. There was a major use of adapted games on account of the benefits they deliver for learning and development of competencies of students with SEN as well as for improving positive attitudes among other students towards diversity and inclusion.

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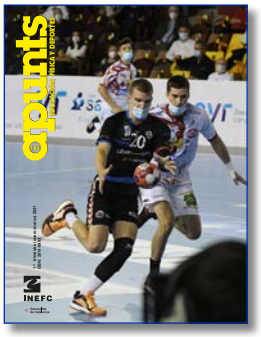
Conflict of Interests: No conflict of interest was reported by the authors.

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.04



OPEN ACCESS

Development of Emotional Intelligence through Dramatisation

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Cite this article:
Castillo Viera, E., Moreno-Sánchez, E., Tornero Quiñones, I., & Sáez Padilla, J. (2021). Development of Emotional Intelligence through Dramatisation. *Apunts. Educación Física y Deportes*, *143*, 27-32. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.04

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Physical Education

Original language:
Spanish

Received:
10 April 2020

Accepted:
8 September 2020

Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

This study analysed the effects of a dramatisation intervention as physical education (PE) content in primary education on emotional intelligence. The management of our emotions and of our relationships with others are key socialisation and intervention tools in the education setting. PE is ideal for the development of these skills since it provides specific contents that could be related to an improvement in self-awareness, expression and communication. The purpose of this intervention was to develop expressive, communicative and critical skills through different dramatisation resources. In order to analyse the effects of this proposal, a quasi-experimental study was designed providing for an analysis between two groups (control and experimental) from an intentional sample of 294 students (141 boys and 153 girls). An emotional intelligence questionnaire for children was administered to the subjects as a pre-test and post-test to evaluate the influence of a dramatisation programme. The SPSS-22 statistical package was used to perform a descriptive analysis of the pre-test-post-test data on the emotional intelligence factors, to wit emotional expressiveness, self-control, motivation, self-awareness and social skills. The Shapiro-Wilk test was applied to determine normality. The differences between pre- and post-intervention were determined with Student's t-test for related samples. Following the data analysis, it may be asserted that dramatisation gave rise to improvements in certain emotional intelligence factors in female students and more notably in male students.

Keywords: dramatisation, physical education, body expression.

Introduction

The premise of this paper is the conviction that the management of our emotions and our relationships with others are key tools for socialisation and intervention in our environment by promoting communication-based relationships. Emotional education is regarded as a continual and permanent learning process that seeks to boost the development of emotional competencies as a key element of students' comprehensive development to prepare them for life (Bisquerra, 2000) and to do away with emotional illiteracy (Bisquerra, 2011). Fernández-Berrocal and Extremera (2002) consider that explicit emotional education is very important in the school setting, as is the teaching staff's influence on such emotions (Pérez-González et al., 2019).

One of the objectives of emotional education is the development of emotional competencies which include emotional awareness, emotional regulation, emotional autonomy, socio-emotional competencies and competencies for wellbeing (Bisquerra, 2003). Physical education is the ideal setting for the development of emotional competencies through motor practice (Alcaraz et al., 2017; Cañabate et al., 2018) for students and teachers alike (Aparicio & Fraile, 2016). It is also the ideal framework for using educational contents and resources linked to the arts of movement, although it could also be addressed as cross-cutting content due to its relationship with emotional intelligence, art, communication and culture in general (Torrents & Mateu, 2015).

The primary education) syllabus, governed by the regulatory framework in Andalusia (BOJA, 2015), establishes that understanding, expression and communication of messages, feelings and emotions should be developed in PE through the body, gestures and movement both spontaneously and creatively and also individually and collectively.

Motos (2018) describes a broad variety of drama activities, including drama games, dramatisation, role-playing, improvisation, simulations, reading texts and individual or group writing. In PE, these activities will be developed as content in the body expression block.

Previous studies have shown that dramatisation content is a suitable resource for the development of emotional intelligence (Cruz et al., 2013; Gallardo & Saiz, 2016; González García, 2015; Motos, 2018; Sánchez & Coterón, 2015). This body expression content is extremely satisfying for students (Rodríguez-Negro & Yanci, 2020) and improves their mood (Torrents et al., 2011). Moreover, it helps to explore and express feelings (Motos, 2018), develops creativity, which in turn is conducive to creating an atmosphere of trust, safety and collaboration (González García, 2015), and can be applied to other motor tasks in physical education (Torrents, 2020).

Based on the foregoing, the following question is asked: Is body expression, and more specifically the technique of dramatisation, a suitable resource for the development of emotional intelligence in PE? To this end, the study's general objective was to analyse the relationship between emotional intelligence factors and a dramatisation programme used with primary school students.

Methodology

The study had a quasi-experimental design.

Participants

A total of 294 students (141 boys and 153 girls) from sixth-year primary education from four schools in Huelva (11 and 12 years) took part in the study. For the purpose of recruitment, the administration of each school and the students' parents were contacted to secure their informed consent. The approval of the Biomedical Research Ethics Portal of Andalusia was requested and obtained.

The simple random sampling technique was used. All of the state primary schools (21) in the city of Huelva were invited to participate, four (19.04%) of which accepted. The sample population selection criterion consisted of choosing several groups from among the primary education classes of the schools participating in the study at random.

The participants were unaware of the study purpose. They were divided into two groups: the experimental group, comprised of 151 students (54.4%) (74 boys and 77 girls) to whom a body expression teaching unit based on dramatisation was applied; and the control group comprised of 143 students (48.6%) (67 boys and 76 girls) who did other PE content not related to body expression. The students participating in the research were distributed homogeneously in the sixth year of primary education.

This year was selected because the dramatic play and creative dramatic content fulfil the requirements of the curriculum design of the PE subject in primary education (BOJA, 2015).

Performance of the intervention programme

The intervention programme conducted in the subject of PE was based on the body expression content block, more specifically dramatisation.

The dramatisation objectives in primary education were: to develop the student's autonomy with a view to

attaining self-awareness and personal development; develop the capacity to express emotions and to give and receive aesthetic messages; develop critical thinking; develop creativity, promoting fluent, flexible and original proposals.

The dramatisation contents in primary education were: lack of inhibition and spontaneity; symbolic play, expression games, functional play, role-playing and improvisation; dramatic forms: puppets, marionettes, masks, shadow play, black theatre, recitals, collective creation, text creation; basic elements of dramatic structure (characters, topic, space and time, the roles of actor and spectator); body expression: body rhythm and movement; exploring and experimenting with material resources (objects, music, sound, wardrobe, lights, decorative items); analysis and assessment of dramatic activities and drama performances.

This was performed for a period of eight weeks with a frequency of two weekly sessions, each one lasting 45 minutes.

The programme was led by postgraduate students with PE qualifications and previous training in body expression and dramatisation who were tutored by members of the research project. The people who taught the sessions were unaware of the study objectives.

Dramatisation is taken to mean a process of creation, interaction and spontaneous responses to conflictive situations; the teaching staff act as facilitators by participating in the experience; the students are the participants and creators of the process; the participants take on the roles of authors, audience, critics, etc.; the work process is open and flexible; the participants construct their proposals and draw from their own experience; the emphasis is placed on communication and the creation process, observing the preparation, incubation, illumination and review phases; the product is not conceived in terms of performance and neither is it a purpose in itself but rather forms part of the expression and communication process.

The teaching unit provided for the three elements of the dramatic event (presentation, crisis and outcome) while also including the elements of character, conflict, space, time, story line and topic.

Instrument

An emotional intelligence questionnaire in children by Porcayo (2013) for children aged between 10 and 12 years, was used. This questionnaire evaluates the index of emotional intelligence divided into five dimensions: emotional expressiveness, comprised of 7 items ("states that they feel good after completing an activity"); self-control, comprised of 8 items ("accepts proposals made by others"); motivation, comprised of 7 items ("when they do something well, they make positive comments about it"); self-awareness, comprised of 5 items ("talks to friends or classmates of their age and reaches agreements with them") and social skills, comprised of 3 items ("has difficulty adapting when going to parties"). A Likert response format for the items was used with 5 options, ranging from 1) "Never" to 5) "Always". In most of the items, the ideal answer is associated with the value of 5, barring items 17, 18, 23, 26, 27 and 28 which are reversed and in which the best-rated option has the value of 1.

According to the Cronbach scale, the alpha coefficients of the five sub-scales showed moderate internal consistency of the corresponding total scores (emotional expressiveness $\alpha = .82$, self-control $\alpha = .83$, motivation $\alpha = .82$, self-awareness $\alpha = .79$, social skills $\alpha = .77$).

The questionnaire was administered at the time established by each school and the students were informed that completing it was confidential and voluntary.

Statistical analysis

The data were analysed with the SPSS statistics software package V.22.0 for Windows. (SPSS Inc., Chicago, USA) and the level of significance was set at $p < 0.05$. The data were displayed with descriptive statistics tests reflecting the mean, standard deviation and percentages. Student's t-test was used to perform comparisons of socio-demographic variables between groups and of the study variables (emotional expressiveness, self-control, motivation, self-awareness, social skills) depending on gender. A pre-test and post-test ANCOVA was performed with gender as a covariant. Subsequently, the comparison of the groups post-test and pre-test was examined with ANCOVA, according to gender and performance in the pre-test (for each variable) as covariants.

Cohen's d is presented as mean effect size (small: 0.2-0.3, medium: around 0.5, and large ≥ 0.8).

Results

Table 1 shows the differences between girls and boys in the variables studied. It should be emphasised that the variables of emotional expressiveness, self-control, motivation and self-awareness were statistically significant in the pre-test. The girls obtained higher scores in all cases. However, effect size was medium for the self-control and motivation variables and low for the emotional expressiveness and self-awareness variables.

Table 1
Descriptive statistics depending on gender.

	Gender	Mean (SD)	*t*	*p*	Cohen's d
Emotional expressiveness pre-	Male	3.68 (.76)	-	< .001	.21
	Female	4.01 (.64)	-4.03		
Emotional expressiveness post-	Male	3.77 (.72)	-	.002	.36
	Female	4.01 (.62)	-3.07		
Self-control pre-	Male	3.66 (.49)	-	< .001	.58
	Female	3.95 (.51)	-4.89		
Self-control post-	Male	3.88 (.50)	-	.172	
	Female	3.96 (.56)	-1.36		
Motivation pre-	Male	3.61 (.58)	-	< .001	.68
	Female	3.99 (.54)	-5.71		
Motivation post-	Male	3.79 (.56)	-	< .001	.41
	Female	4.01 (.50)	-3.60		
Self-awareness pre-	Male	3.90 (.60)	-	.021	.27
	Female	4.06 (.57)	-2.32		
Self-awareness post-	Male	3.97 (.62)	-	.219	
	Female	4.06 (.63)	-1.23		
Social skills pre-	Male	2.91 (1.19)	-	.330	
	Female	3.04 (1.16)	-.977		
Social skills post-	Male	3.22 (1.21)	.875	.382	
	Female	3.10 (1.20)			

In the post-test, the significant variables were emotional expressiveness and motivation, with the girls obtaining the highest score and with a low effect size.

No significant gender-related differences were obtained in the remaining post-test variables.

Subsequently, an ANCOVA was performed to study the pre- and post-test variables of the control and experimental groups. There were no significant differences between the control and experimental groups according to gender.

Table 2 presents the significant differences ($p < .05$) observed between the experimental group and control group from the pre- to post-test evaluation. Following the intervention, increases in emotional intelligence were observed in the emotional expressiveness, self-control, motivation and self-awareness variables in the experimental group.

Discussion

The objective of this study was to analyse the relationship between emotional intelligence factors and a dramatisation programme applied to primary school students. Following the data analysis, it may be stated that this dramatisation programme promotes the development of different dimensions of emotional intelligence such as emotional expressiveness, self-control, motivation, self-awareness and social skills.

Table 2
Effect of 8 weeks of body expression on the students' emotional intelligence.

	Pre-test	Post-test	Pre-post difference
Emotional expressiveness			
CG	3.93 (.75)	3.84 (.72)	-.090 (.67)
EG	3.79 (.70)	3.95 (.64)	.167 (.51)
p-value (groups)	NS	NS	.001
Self-control			
CG	3.89 (.53)	3.81 (.53)	-.081 (.56)
EG	3.74 (.52)	4.03 (.52)	.290 (.44)
p-value (groups)	NS	< .001	< .001
Motivation			
CG	3.91 (.56)	3.85 (.58)	-.064 (.57)
EG	3.72 (.61)	3.96 (.50)	.242 (.57)
p-value (groups)	NS	NS	.001
Self-awareness			
CG	3.99 (.62)	3.89 (.70)	-.111 (.69)
EG	3.98 (.57)	4.15 (.53)	.168 (.55)
p-value (groups)	NS	< .001	< .001
Social skills			
CG	3.08 (1.23)	3.05 (1.11)	-.03 (1.11)
EG	3.24 (1.18)	3.39 (1.22)	0.15 (1.17)
p-value (groups)	NS	.019	NS

Authors such as Motos (2018) showed that dramatisation activities help to explore and express feelings and may be used as a teaching strategy for students' emotional development (Cruz et al. 2013) or as content by drawing on the everyday situations students experience (Gallardo & Saiz, 2016). Sánchez and Coterón (2015) argue that experimenting in the movement arts, whether as a performer, spectator or choreographer, is conducive to students' emotional development.

The results also suggest that this dramatisation programme led to notable improvements in emotional intelligence levels among male students with regard to emotional expressiveness, self-control and self-awareness. These results are similar to the intervention performed by Domínguez and Castillo (2017) which found that dancing as body expression content promotes greater awareness of emotions and feelings.

This dramatisation programme has given rise to significant improvements in the various emotional intelligence factors among female and male students, with the most outstanding improvements achieved by the male students.

Although there is evidence of the relationship between dramatisation and emotional intelligence, these data should be interpreted with care and further research in this field is required to be able to mainstream and extrapolate the findings to other settings.

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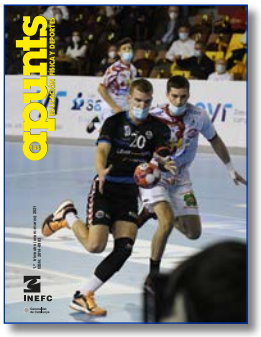
Conflict of Interests: No conflict of interest was reported by the authors.

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.05



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Situational and Game Conditioning Factors in Goals Scored with a Fly Goalkeeper in Futsal

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Cite this article:
Méndez-Domínguez, C., Bores-García, D., Ruiz-Barquín, R., Gómez-Ruano, M., & Ruiz-Pérez, J.M. (2021). Situational and Game Conditioning Factors in Goals Scored with a Fly Goalkeeper in Futsal. *Apunts. Educación Física y Deportes*, *143*, 33-43. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.05

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Sports training

Original language:
Spanish

Received:
30 May 2020

Accepted:
17 September 2020

Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

The purpose of this study was to analyse goals scored with a fly goalkeeper and to establish an efficacy profile depending on situational and game variables. Astrofutsal® software was used to analyse a sample of 582 goals from 11,446 fly goalkeeper situations in 1,200 matches from the National Professional Futsal League between the 2010 and 2015 seasons. The impact of the situational (opponent quality, match status and match location) and game (goal area, shot type, number of passes and number of players) variables as predictors of goals was analysed by means of two-step cluster analysis. The results demonstrated, in situational terms, the greater importance of having at least the same level as the opponent and playing either at home or away when it comes to scoring goals and getting back into the game with a fly goalkeeper and, in game terms, the importance of executing short attacks (1-10 passes) that end in the area (precision goal) or with an outside shot (surprise goal) as characteristic goal patterns with a fly goalkeeper. The trends identified may help coaches to design a more suitable and productive numerical superiority scenario.

Keywords: team sports, offensive tactics, contextual variables, performance analysis, two-step cluster analysis.

Introduction

5v4+G is a futsal tactical procedure that uses the goalkeeper acting as an outfield player, modifying their regular strategic motor role so that coaches can use players who are not usually goalkeepers to take on functions or engage in specific actions of the game that distinguish them from other players (Hernández, 2001). This enables them to defend their goal but also to leave the goal and participate in offensive actions in order to achieve numerical superiority over defending opponents, in other words 5v4, and seek to obtain performance-related advantages(Vicente-Vila & Lago-Peñas, 2016).

This tactic has been extensively used in the sport since FIFA introduced it into the laws in 2006 and is one of the used training contents most used by coaches in the course of the season (Alvarez et al., 2004). Nevertheless, its theoretical advantage has been little studied, meaning that most of the studies suggest a lower-than-expected effectiveness in ball possession with 5v4+G (Barbosa, 2011; Ganef et al., 2009). This could be related to the decisive role played by certain context-specific variables in the absolute effectiveness of 5v4+G (Méndez, 2017) which, if they were known by coaches, might result in better use of the procedure and ultimately make it more effective (Méndez, 2018; Méndez et al., 2017).

In most of the studies pertaining to performance analysis in futsal, 5v4+G is usually compared to other offensive tactical systems in order to emphasise the importance of goals and shots as the main indicators of team effectiveness in attack. 5v4+G attack and defence against the 5v4+G attack emerge as the least successful forms of offensive organisation in terms of number of goals scored compared to the counter-attack, positional attack and set pieces, in this order (Fukuda & Santana, 2012; Marchi et al., 2010; Poffo & Lima, 2012).

Recent research focusing on comparing 5v4+G and 4v4+G has shown that the numerical and positional advantage that can be obtained with 5v4+G is related to more finishing chances (Ferreira-da-Silva, 2011) and performance in the form of shots (Corrêa et al., 2014; Vicente-Vila, 2012, 2014) or goals (Vicente-Vila, 2014; Vicente-Vila & Lago-Peñas, 2016) in the attack phase, compared to the symmetrical competitive scenario of 4v4+G. Nevertheless, it is still regarded as a risky procedure because the rival team (in the defensive phase) can take possession of the ball and generate a rapid shot on goal when there is no specific goalkeeper defending it, giving rise to changes on the scoreboard that can ultimately tip the scales one way or the other (Ganef et al., 2009; Newton-Ribeiro, 2011).

Some authors have described the effectiveness of ball possession in futsal with regard to the game's structural characteristics, focusing on the importance of the finishing space, the number of passes and the number of players. With regard to 5v4+G, Vicente-Vila (2014) found that the central areas and areas close to goal yield a better rate of offensive effectiveness.

However, the procedure's greater or lesser degree of success might be conditioned by the context in which the actual attack takes place, which may limit players' behaviour due to the possible presence of a hostile environment and/or if the team is losing against a specific opponent (Méndez, 2017). In fact, 5v4+G is usually deployed in practice as a regular strategic tactic (between 90% and 100% of cases of ball possession in attack) when the team is losing by one or more goals (Barbosa, 2011; Vicente-Vila, 2014) and in the closing minutes of the match (Ganef et al., 2009; Newton-Ribeiro, 2011). These two factors present characteristics common to what is normally known as the critical moment which expert futsal coaches recognise as triggering a response that coincides with the appearance of 5v4+G (Méndez et al., 2017) and as a key point that strongly conditions the opportunities of a getting a shot in with 5v4+G and may decide the final outcome of futsal matches (Méndez et al., 2019). The presence of variables such as match location and the rival's skill has also been investigated with a view to predicting performance success (Sampedro & Prieto, 2012) and may boost or minimise the effects of a "critical" scenario.

However, although it can be used as an advantage that is allowed by the laws and is a tactic to which coaches resort increasingly more regularly in the course of the match, the available literature related to 5v4+G in futsal is meagre, probably due to the fact that performance analysis in futsal through the compilation of these variables is somewhat complex (Vicente-Vila & Lago-Peñas, 2016).

It is necessary to identify the situation and game variables that may condition the outcome of elite futsal matches, seeking through this approach to improve the understanding of the dynamics of play and the strategies of the different possible superiority scenarios (Gómez et al., 2018). In this way, some authors have used cluster techniques as a suitable statistical model when attempting to explore and model such data in team sports (Gómez et al., 2018).

The objective of this study was to analyse the impact of clustering certain situational and game variables to determine their degree of importance as predictors of goals scored, not conceded, when the 5v4+G attack procedure is used, and whether this relationship may define a characteristic performance profile structure of this type of attack in conditions of superiority implemented by elite futsal teams.

Material and method

Participants

This study analysed a total of 582 goals scored in the 11,446 5v4+G situations used by coaches in the course of 1,325 matches in the regular and play-off phase of the 2010-2011, 2011-2012, 2012-2013, 2013-2014 and 2014-2015 seasons of the futsal First Division (LNFS). Astrofutsal® (Méndez & Méndez, 2005), which has been the statistics supplier of the National Futsal League (LNFS) since the 2004/05 season, stipulated the condition of obtaining informed consent. Access to its datasets requires a fee-bearing licence and applications must be submitted through registration at www.astro-sport.com. This platform granted the authorisations needed to use the data contained in its statistical reports for research purposes in order to avoid conflicts of interest. The local Institutional Review Board (INEFC) approved the study.

Observational design

An observational methodology with an ideographic, specific and multidimensional design was used (Anguera & Hernández, 2013). For data collection, an ad hoc observation instrument was designed, comprised of a system of variables and categories designed specifically for this research.

Observation instrument

The observation system, specific for recording goals scored with a fly keeper, was configured and designed in the game variables section (Table 1) and in the field diagram (Figure 1) by a panel of eight experts who are high-performance specialists in futsal and practising first-division coaches with the highest qualifications in the sport. The categorical variables model used by other authors in relation to similar studies (Méndez-Domínguez et al., 2019) was used in the situational variables section. The system is comprised of 23 categories distributed in seven variables (Table 1 and Figure 1) which fulfil mutually exclusive and collectively exhaustive (MECE) conditions.

Recording instrument

Astrofutsal ® software was used to facilitate the recording of goals scored with 5v4+G and their subsequent coding (Méndez & Méndez, 2005). The software's construct validity was performed by a panel of experts who had to fulfil the requirement of having been European and/or world futsal champions with their national teams. Four experts were finally chosen.

Two expert observers with 12 years of experience in futsal event notational analysis using this tool were involved in the data quality process. For inter-observer

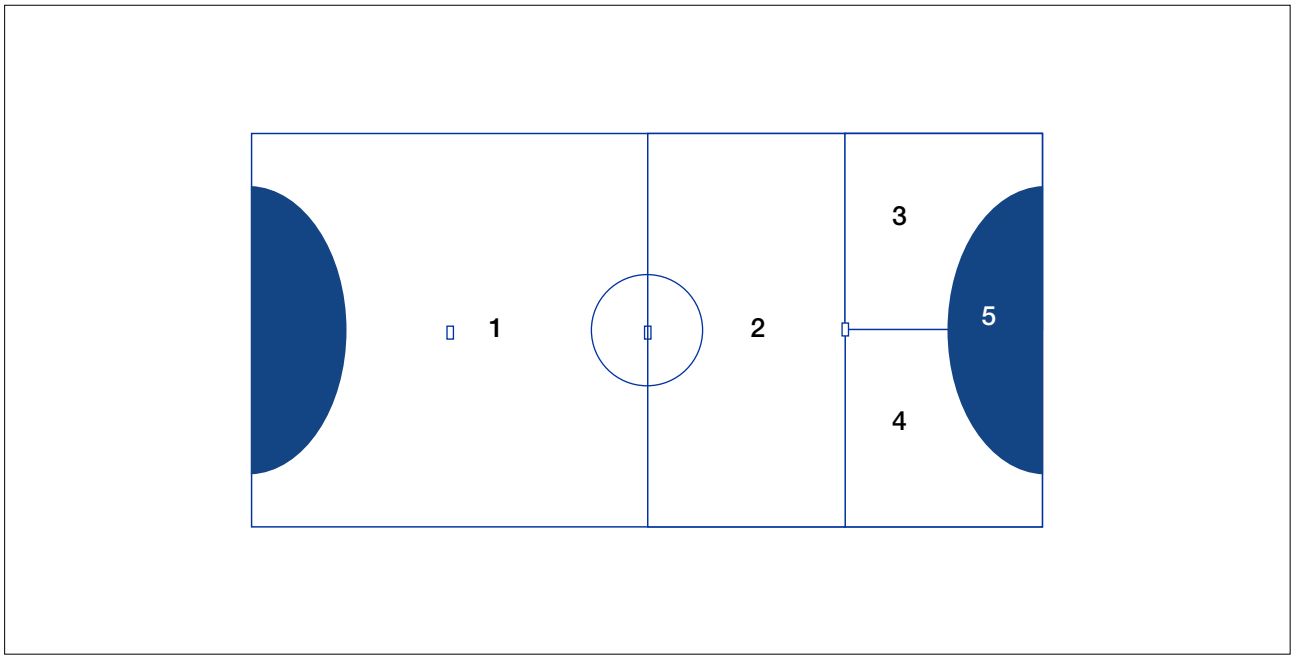

Figure 1
Information from the final goal areas in attack with 5v4+G.

Table 1
Definition of the observation instrument's category system.

Dimensions	Criteria	Code	Categories	Code	Description
situational					
	Match Status	MS	Losing	LOS	Goal by losing team
			Drawing	DRA	Goal by team while match is drawn
			Winning	WIN	Goal by winning team
	Opponent quality	QO	Better uses 5v4+G against worst	BEST	Goal by best team using 5v4+G
			5v4+G between same-level teams	EQU	Goal by one of the teams of the same level and one of them with 5v4+P
			Worst uses 5v4+G against best	WORST	Goal by worst team using the tactic
	Goal location	GLV	Goal 5v4+G home	HG	Goal by home team with 5v4+G
			Goal 5v4+G away	AG	Goal by away team using 5v4+G
game					
	Area	FA	1 1/2 pitch	A1	Goal scored in 1/2 pitch
			2 10-20 m	A2	Goal scored between 10-20 m
			3 Left attack	A3	Goal scored in left area attack
			4 Right attack	A4	Goal scored in right area attack
			5 Goal area	A5	Goal scored in goal area
	Shot type	ST	Outside shot	OS	Goal outside a heavily defended area
			Inside pass (pass, 1-2, 1x1)	IP	Goal inside a heavily defended area
			Far post:	FP	Goal with an attacking player reaching the far post
	No. players	NP	1	1P	Goal involving 1 player
			2	2P	Goal involving 2 players
			3	3P	Goal involving 3 players
			4	4P	Goal involving 4 players
			5	5P	Goal involving 5 players
	Pass sequence	PS	1-10 passes	PS<10	Goal with a sequence of less than 10 passes
			11 forward passes	PS>10	Goal with a sequence of more than 10 passes

reliability, the match between Pozo de Murcia and Inter Movistar in the 2014-2015 Play-off final series was analysed first, followed by 58 (10%) of the 582 goals scored with the 5v4+G procedure chosen at random in order to be labelled with regard to the study variables. The two observers recorded the main futsal events during the match and subsequently characterised the 5v4+G goals. The records were compared using Cohen's Kappa coefficient (k) (Robinson & O'Donoghue, 2007), obtaining Kappa values for the events of both teams of 0.91 and 0.92, respectively, with the Kappa value of the 5v4+G goal actions being 0.89 and 0.88, respectively.

Statistical procedure and analysis

All the variables studied and their corresponding frequencies and percentages are shown in Table 2. Each one of the goals scored with 5v4+G was characterised around nominal or categorical variables pertaining to two dimensions. The situational variables included (i) Match Status (MS), according to which it was established that a team could be winning, drawing or losing; (ii) Match location (HAG= home/away goal), to distinguish between the team scoring a goal with 5v4+G playing at home (HG= home goal) or away from home (AG= away goal); (iii) Opponent quality (OQ), based on the classification of the 16 teams at the end of the normal season, was measured by the difference in classification at the end of the season between both teams (Classification A - Classification B), and three groups were established according to the k-means clustering (best-classified does

Table 2
Distribution of frequencies and % of goals scored with 5v4+G.

Criterion	Categories	Code	*n* of each criterion= 582	%
Match Status	Losing	LOS	508	87.3
	Drawing	DRA	61	10.5
	Winning	WIN	13	2.2
Opponent quality	Best uses 5v4+G against worst	BEST	71	12.2
	5v4+G between same-level teams	EQU	368	63.2
	Worst uses 5v4+G against best	WORST	143	24.6
Goal location	5v4+G home goal	HG	267	45.9
	5v4+G away goal	AG	315	54.1
Area	1 1/2 pitch	A1	1	.2
	2 10-20 m	A2	66	11.3
	3 Left attack	A3	71	12.2
	4 Right attack	A4	85	14.6
	5 Goal area	A5	359	61.7
Shot type	Outside shot	OS	114	19.6
	Inside pass (pass, 1-2, 1x1)	IP	328	56.4
	Far post:	FP	140	24.1
No. of players	1	1P	5	.8
	2	2P	42	7.2
	3	3P	89	15.2
	4	4P	204	35
	5	5P	242	41.5
Pass sequence	1-10 passes	PS<10	111	19.1
	11 forward passes	PS>10	471	80.9

5v4+G against worst; teams with a similar classification and one of them acts with 5v4+G; worst-classified does 5v4+G against best).

The game variables included in the final model were (iv): Finishing area (FA), distributed into sectors according to Lapresa et al. (2013), but with a different sectorial organisation, where five different areas with their own significance were established (Fig. 1); (v) The pass sequence (PC= pass cluster) carried out between the attacking players before the final shot that ends in a goal was established by means of k-means clustering, establishing short sequences (1 and up to 10 passes) and long sequences (11-36 passes); (vi) The shot type (ST) taken ending in a goal with 5v4+G was categorised into three types with the help of experts: a) Outside shot, taken without entering the opponent's defensive system or with 4 opposing players and the goalkeeper ahead of the ball; b) Inside shot after a pass, penetration, running with the ball, 1-2, 1x1 or block, and c) shot after a pass to the far post after ball movement; and (vii) Number of players (NP) who played the ball with 5v4+G to break through the defence, including a range comprising the participation of one player alone and up to the 5 players.

The statistical analysis consisted of two-step cluster analysis: first of all, the variables were selected to verify the relationships of dependence and to check that the variables included in the cluster model were not statistically significant versus each other using the contingency tables procedure. Secondly, a two-step cluster analysis was performed, selecting the log-likelihood distance measure for the calculation of similarity between two clusters and using a Schwarz information criterion (SIC) algorithm to detect all the homogeneous clusters according to the values observed in this apparently heterogeneous set (Vila-Baños et al., 2014). In it, an attempt was made to explore and discover the natural clusters of the overall set of goals scored with 5v4+G with regard to a dimensional model related to the game variables and another one related to the situational variables.

When determining the validity of the models, the aim was to characterise the clusters according to the variables included in them, yielding standardised weightings to support the cluster distribution and to afford them significance with regard to the goals scored with 5v4+G. The statistical analyses were performed using IBM SPSS for Windows, version 22.0 (Armonk, NY: IBM Corp.) software.

Results

The preliminary tests by means of crosstabs and chi-square tests verified the conditions of independence between the situational variables and also between the game variables. The two-step cluster analysis technique reported that both models considered all the variables entered and was sufficient in the case of the game variables and good in the case of the situational variables and they were therefore accepted. This made it possible to identify different types of attack when the teams were playing in conditions of numerical superiority with 5v4+G. Tables 3 and 4 display the information for each group and the importance of each variable in the model and for each cluster. Figures 2 and 3 show the size of each cluster, with each of the variables considered in both models, sorted from most to least important and with the predominant category and weighting inside them.

In the case of the situational model (Fig. 2), six clusters were obtained including the three variables sorted from most to least important, the most important being OQ and the least important being HAG. The characteristics of the two most important groups of this model indicated that 31.4% of the

Table 3
Information from the situational variables according to the cluster.

Cluster	6	5	4	2	1	3
Total frequencies and between category	31.4%; *n* = 183	23.9%; *n*= 139	12%; *n*= 70	11.9%; *n* = 69	11.7%; *n* = 68	9.1%; *n* = 53
OQ (I= 1)	100% 5v4 between equals	100% 5v4 between equals	100% Worst does 5v4	66.7% 5v4 between equals	100% Worst does 5v4	100% Best does 5v4
MS (I= 0.54)	100% Losing	100% losing	98.6% losing	88.4% drawing	100% losing	92.5% losing
HAG (I= 0.46	100% Away goal	100% Home goal	100% Away goal	56.5% Home goal	100% Home goal	60.4% Away goal

Note. I: importance of the variable in the model: OQ: Opponent quality; MS: Match Status; HAG: Home or away goal.

Table 4
Information from each game-related variable according to the cluster.

Cluster	1	2	3
total frequencies and between category	48.8%; *n* = 280	32.1%; *n* = 184	19.2%; *n* = 110
PC (I= 1)	100% between 1-10 passes	100% between 1-10 passes	100% between 11-36 passes
EA (I= 0.74)	100% goal area	35.3% right side	66.4 % goal area
ST (I= 0.38)	61.1% 1x1, pass, 1-2	55.1% outside shot	58.2% 1x1, pass, 1-2
NP (I= 0.22)	41.4% 5 players	44% 4 players	85.5% 5 players

Note. I: importance of the variable in the model: PC: Pass cluster; EA: end area; ST: Shot type; NP: Number of players involved.

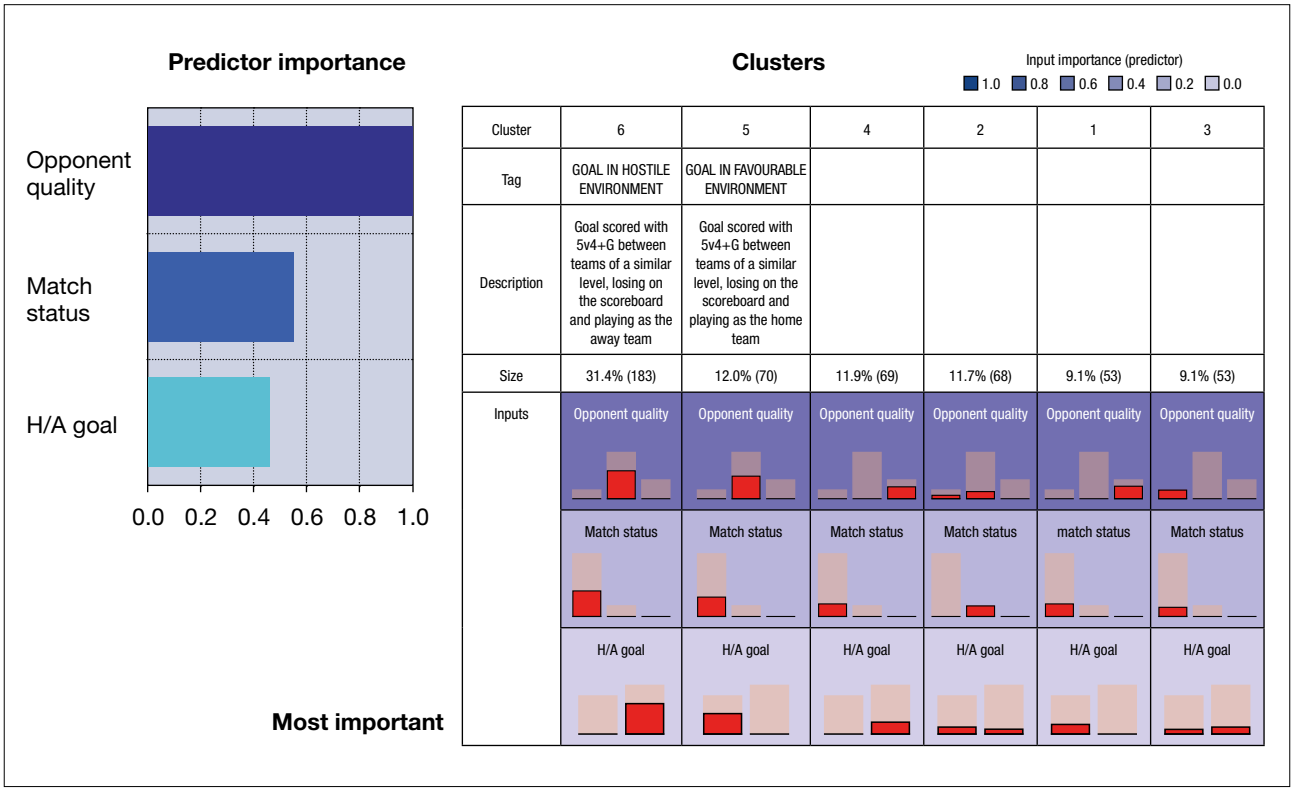

Figure 2
Information from the clusters related to the situational variables and their importance.

sample of goals scored with 5v4+G were characterised by being scored with 5v4+G between teams of a similar level (100%), the team with 5v4+G was at a disadvantage (losing) on the scoreboard (100%) and was the away team (100%). On account of its characteristics, this goal has been called 5v4+G goal in a hostile environment. The second most important group characterised 23.9% of the sample of goals scored with 5v4+G when it was between teams of a similar level (100%), with the team using 5v4+G at a disadvantage (losing) on the scoreboard (100%) but playing as the home team (100%). On account of its characteristics, this goal has been called 5v4+G goal in a favourable environment.

With regard to the game model (Fig. 3), three clusters were obtained with the most important variables being passes (PC) and EA, while the least important one was NP. The characteristics of the two most important groups

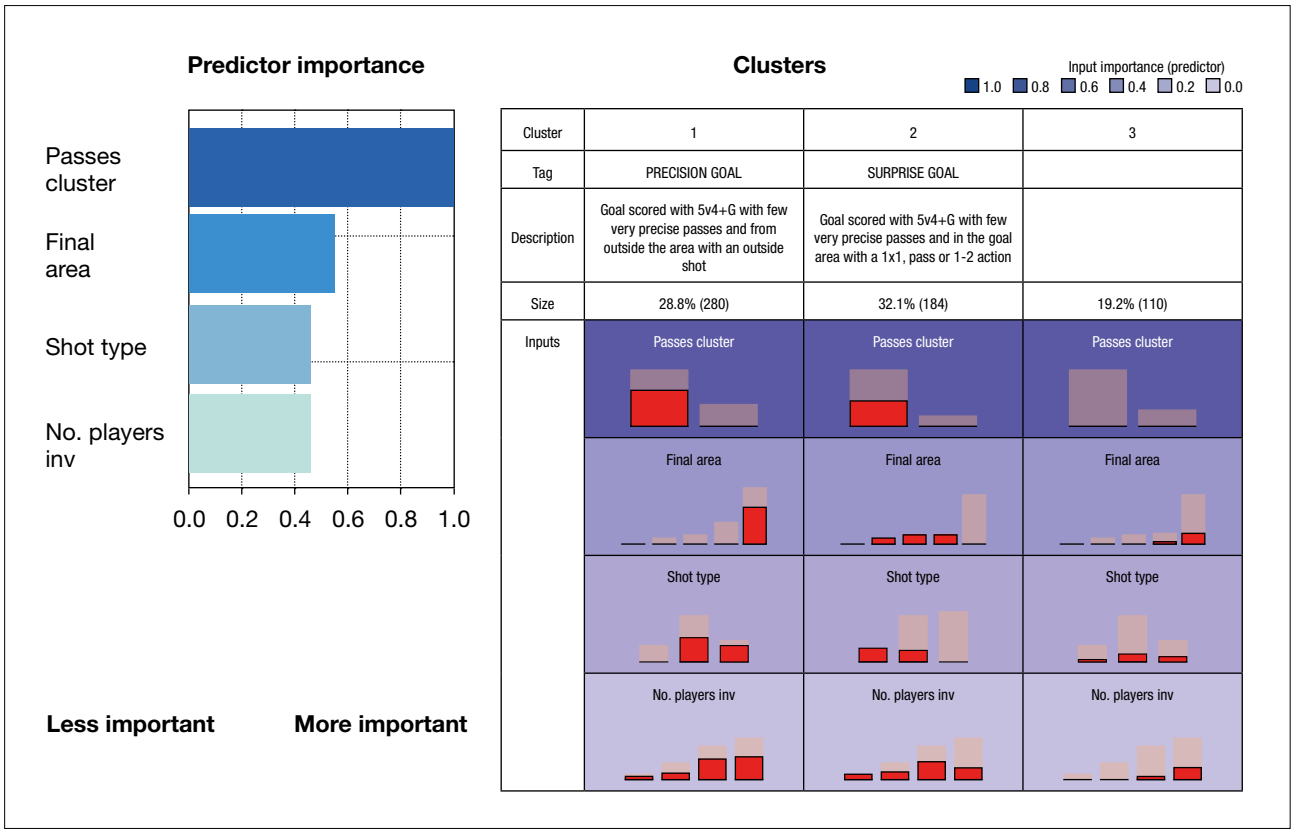

Figure 3
Information about the clusters related to the game variables and their importance.

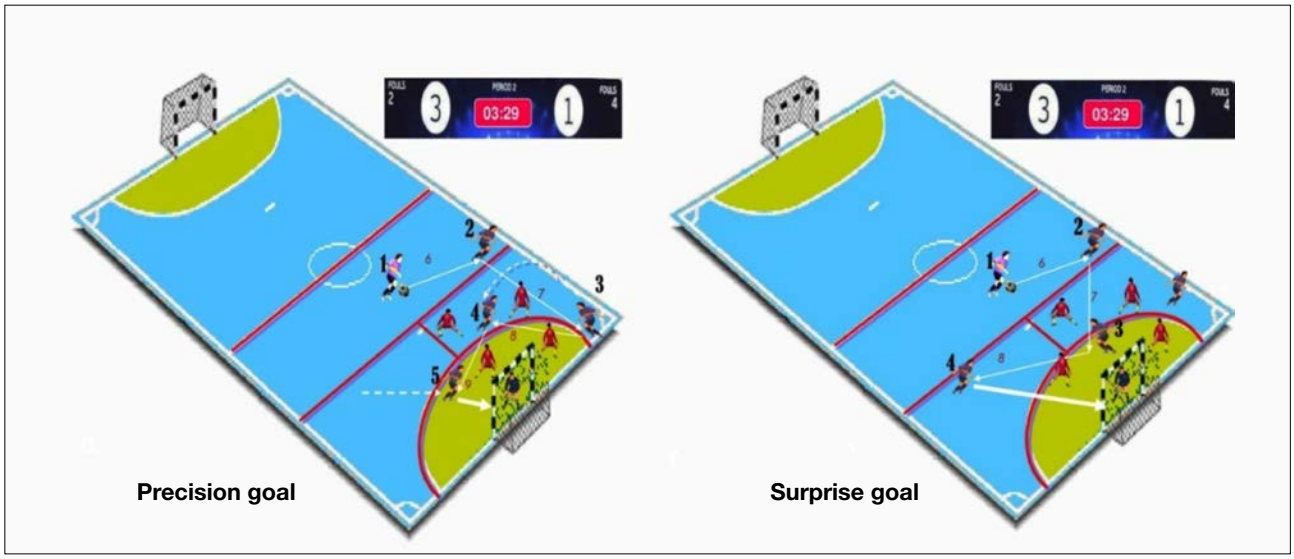

Figure 4
Characteristic pattern of goals scored with 5v4+G in relation to the information provided by the clusters.

established a first group with 48.8% of the sample of goals scored with 5v4+G obtained by means of a sequence of between 1 and 10 passes (100%), shooting in the area (100%), with a 1x1 action, pass, 1-2 (61.1%), and involving the 5 players (41.4%). This goal has been called the precision goal. The second group included 32.1% of the sample and was characterised as being a 5v4+G goal obtained with a sequence of between 1 and 10 passes (100%), which ended

on the right side of the attack (35.3%), with an outside shot (51.1%), and with the participation of 4 players (44%). The goal has been called the surprise goal.

A possible characterisation of the goal scored with 5v4+G in relation to the evolution of the game and the context is displayed in Figure 4.

Discussion

The objective of this study was to identify the situational variables (HAG, MS and OQ) and game variables (NP, PC, ST and EA) with the greatest affinity to the goal scored, not conceded, with 5v4+G, and to be able to establish a characteristic profile of this type of attack involving numerical superiority in professional futsal. In line with the posits of previous studies, coaches seek to identify their opponents' strong and weak points as a team as a way of controlling and administering their strategies and tactics in the course of the match (Sarmento et al., 2015).

The results showed that the total number of goals scored with 5v4+G (582) in relation to the total number of actions with this procedure (11,446) came to a somewhat low proportion (5.1%). In accordance with the rationale of the study, this finding tallies with the low effectiveness of ball possession with 5v4+G (Barbosa, 2011; Ganef et al., 2009) and with the tag of worst type of attack compared to the other forms of offensive organisation (Fukuda & Santana, 2012; Marchi et al., 2010; Poffo & Lima, 2012). These results could be consistent with the need to perform a suitable diagnosis of the use of 5v4+G that might optimise the key moments when it is used. This may happen by coaches anticipating the moment 5v4+G is used in an attempt to prevent it from taking place at the same time as a critical moment (Méndez et al., 2017), but also through a change in their mindset to no longer regard it as a last resort and instead make it an alternative to symmetrical play (Ganef et al., 2009; Newton-Ribeiro, 2011), thus leveraging the laws (Méndez, 2018).

With regard to the situational variables, the two-step cluster analysis demonstrated the much greater importance of OQ compared to MS and HAG. To a certain extent this situation is only to be expected because the rationale behind attack actions with 5v4+G is that the teams are losing and are trying to get back into the match (Newton-Ribeiro, 2011), and so the temporary MS may not be as relevant as expected in scoring the goal and HAG is equally less important. This result tallies with the study by Vicente-Vila and Lago-Peñas (2016) who ascertained an unexpected non-significant influence of game location (HAG) and match status on the likelihood of success in ball possession.

The HAG variable is even less important. Vicente-Vila and Lago (2016) also found that match location had no impact on ball possession effectiveness. Moreover, Vicente-Vila (2014) found a greater number of away than home goals in 5v4+G situations, concluding that playing at home or away was not related to the successful offensive outcome of possession units in futsal. In fact, according to Oliveira et al. (2012) this variable depends more on the opponent's level (OQ) and on certain intervals during the game, which could explain why the away team scored 100% of the goals with 5v4+G in the most important cluster at the situational level (31.4% of the goal sample).

Secondly, the cluster analysis showed that the two most important factors associated with goals were PC and EA. The most important cluster characterised the precision goal (48.8% of the sample), with a low pass sequence (1-10 passes) and shot in the goal area, which tallies with other futsal studies in which the greatest success of ball possession in 5v4+G was related to the low number of passes made and shots taken in the goal area (Lapresa et al., 2013; Vicente-Vila & Lago-Peñas, 2016).

In general terms, the distribution of the goals scored with 5v4+G is characterised by a more elaborate build-up of possession, seeking through a higher number of passes (11-36 = 80.9%) and with the involvement of the 5 available players (41.5%) to achieve effective finishing situations, although in the two most important clusters greater importance is attached to the lower pass sequence (1-10). This situation does not appear to contradict the results found in other studies where finishes ending in a goal with 5v4+G were associated with possession units with a number of passes equal to or greater than 4-5 (Vicente-Vila, 2012, 2014). However, the use of positional attacks that maintain ball possession appears to increase density of passes between players and also improves their effectiveness due to greater flexibility in the way they play (Sarmento et al., 2016). Consequently, in the event of a substantial effect using a lower pass sequence (cluster 1 and 2 = 1-10 passes) this could be related to an increase in ball movement speed and greater passing precision.

Most of the 5v4+G attacks that end in a goal do so in the goal area (61.7%; n = 359), which is seen in the most important cluster which characterises 48.8% of the sample and where this category reaches 100% of cases. These results concur with the important effect related to goalscoring that researchers have attributed to the goal area zone. Vicente Vila (2014) and Vicente-Vila and Lago-Peñas (2016) found that greater effectiveness in ball possession was accomplished when the team's possession ended in the goal area zone, concluding that the central and close-to-goal areas present

a higher rate of offensive effectiveness. Moreover, more than 70% of shots that end in a goal in futsal were taken from the central areas and inside the goal area, with this zone presenting statistical significance related to successful possession units in attack (Lapresa et al., 2013), meaning that there is therefore a significant association between the EA of the goal zone and the increased offensive effectiveness of possession units (Lima-Pessoa et al., 2009).

This study has certain limitations that should be addressed in the future. First of all, it describes 5v4+G attacks, meaning that the analysis of this superiority procedure should be studied and compared to the most common superiority contexts in futsal (4v3+G and 5v3+G). Secondly, the research should be extended with new situational and game-related variables that would make it possible to further our understanding of their relationship with effectiveness.

Conclusions

The analysis of the goals scored with 5v4+G showed the importance of situational and game variables which may yield established regular patterns related to team behaviour and performance during this strategic procedure. The importance of implementing a 5v4+G attack with at least the same level of skill as the opponent and with a low-pass sequence (1-10 passes) ending in the goal area was demonstrated. Furthermore, the two-step clustering technique made it possible to reflect the basis of the predictive models with the identification of 5v4+G attack patterns according to the importance of the situational variables (goal in favourable environment and goal in hostile environment) and game variables (precision goal and surprise goal). Further research in other leagues should be conducted in order to compare findings, although the information is extremely relevant to the action of the coach and for the definition of strategy during the game to be reproduced in specific scenarios in an attempt to anticipate the types of behaviour that may occur during the match (Sarmento et al., 2016).

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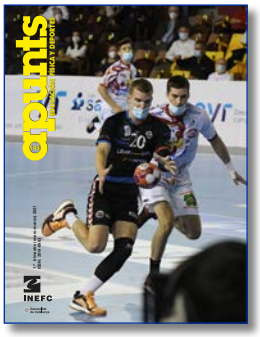
Conflict of Interests: No conflict of interest was reported by the authors.

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.06



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Heart Rate Variability and Accelerometry: Workload Control Management in Men's Basketball

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Cite this article:
Zamora, V., Capdevila, LL., Lalanza, J.F., & Caparrós, T. (2021). Heart Rate Variability and Accelerometry: Workload Control Management in Men's Basketball. *Apunts. Educación Física y Deportes*, *143*, 44-51. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.06

Editor:

ISSN: 2014-0983

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Section:
Sport Training

Original language:
Spanish

Received:
3 April 2020

Accepted:
7 October 2020

Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/lafototeca.com

Abstract

With a view to ascertaining the existence of possible relationships between internal load and external load in basketball, a prospective, observational and descriptive study was performed spanning 20 training sessions during the competitive season of a men's amateur basketball team. Heart rate variability was recorded over 10 sessions using Fitlab® software, and it was subsequently recorded in a further 10 sessions by means of accelerometry with Polar Pro Team® software. The exercises performed and their specificity were analysed; the RRmean, SDNN, RMSSD, pNN50, SHRZ, %SHRZ internal load variables; and the external load variables, namely level 1 accelerations, 0.5 to 0.99 m/s^2; level 2 accelerations, 1 to 1.99 m/s^2; level 3 accelerations, 2 to 2.99 m/s^2; level 4 accelerations, 3 to 50 m/s^2; level 1 decelerations, –0.5 to –0.99 m/s^2; level 2 decelerations, –1 to –1.99 m/s^2; level 3 decelerations, –2 to –2.99 m/s^2 and level 4 decelerations, –3 to –50 m/s^2. A correlation analysis showed significance between external and internal load (SDNN and Total Ac-Dec; rho = .78, p = .004) and specificity (SHRZ and exercise; rho = .89, p = .012). Multiple linear regression analysis showed that internal load (RRmean) depends on external load (total accelerations and decelerations; R^2 = .84). A linear regression indicated that internal load (%SHRZ) also depends on the specificity of the training (R^2 = .59). The results suggest significant relationships between internal load, external load and exercise specificity during training.

Keywords: internal load, external load, HRV, %SHRZ, RRMean, accelerations, decelerations.

Introduction

Internal load (IL) has proven to be useful in guiding the training process in basketball (Sansonea et al., 2019), controlling fatigue (Pyne & Martin, 2011) and preventing injuries (Ivarsson et al., 2013) in a sport involving major physiological and psychological stress (Moreira et al., 2012). One parameter for measuring IL is heart rate variability (HRV), regarded as an effective tool in monitoring adaptation to daily load and to the training programme (Capdevila et al., 2008). The RR record (electrocardiographic interval between two successive R waves) can be used to obtain time parameters that define HRV: mean of the RR intervals (RRmean), standard deviation of the RR intervals (SDNN), root mean square of the successive differences of RR intervals (RMSSD), and percentage difference of the normal adjacent RR intervals >50m/s (pNN50) (Moreno et al., 2013). These time parameters are associated with predominance of the parasympathetic system and as a global indicator, among others, of a sportsperson's psycho-physiological fatigue (Schmitt et al., 2015). Another parameter related to heart rate (HR) in basketball is SHRZ (Summated-Heart-Rate-Zones) (Edwards, 1993; Soligard et al., 2016). This is based on the time spent in predefined HR intensity areas according to five discrete areas of HR in relation to HR_{max} (maximum heart rate). A multiplier accompanies each HR zone that attributes greater weight to higher relative HR responses that are typical of acyclic sports such as basketball (Scanlan et al., 2014).

External and internal loads (EL and IL, respectively) are related, the former being defined as an external physical stimulus applied to the sportsperson during training (or competition) (Soligard et al., 2016). Accelerometry is a tool which can be used to quantify EL (Boyd et al., 2011). Coaches can employ these devices to adjust loads (Foster, et al., 2017) in order to reduce the risk of players sustaining injuries during the season (Caparrós et al., 2018).

Both IL and EL are parameters used to independently assess the effect of training on a player and their control is integrated into training in amateurs and professionals alike (Foster et al., 2017). A certain EL will induce different individual physiological and psychological responses in the same team; this response is the IL (Soligard et al., 2016). Assessing the relationships between both loads on an individual basis provides specific information about each player as a specific tool in order to control adaptation (Impellizzeri et al., 2019) and recovery (Guillaumes et al., 2018) processes.

Analysing these variables in the course of training sessions during the season will enable the coaching staff to design exercises to better adapt workloads to the required objectives. As for its applicability to basketball, Schelling and Torres (2013) propose a classification to facilitate load programming and control without the direct use of technologies because the specificity of the exercises is divided according to levels of approach. The exercises may be general (levels 0^-, 0^+, I), directed (levels II, III), special (level IV) and competitive (level V) depending on the orientation of the task and player needs. Relating this to exercises, 1v0, 2v0 and 3v0 (exercises including up to 3 players without opposition) would correspond to level III. The special level IV would comprise 2v2, 2vX, 3v3, 3vX, and 4vX (small-sided game in equal, inferior or superior conditions); and level V would correspond to 4v4, 5vX and 5v5 (8 players upwards, small-sided game, superiority or real play).

The objective of this study was to assess the possible relationships between IL (based on HRV) and EL (based on accelerometry) in the different levels of approach to training exercises in amateur basketball.

Methodology

Participants

Twelve players took part in the study (age: 26.5±8.8; height: 190±7 cm; weight: 92±6.2 kg) from a men's basketball team in the Copa Catalunya division in the competitive period of the 2018-2019 season. The entire team and its echelons (players, coaches and management) were informed about the study and provided their consent for it to be performed. Data use fulfilled the standards of the Helsinki Declaration, revised at Fortaleza (World Medical Association, 2013).

Variables recording

Each player was given a chest strap (Polar Team Pro Sensor) to record the RR intervals (time between consecutive heartbeats in milliseconds) and the accelerometry. These devices contain a pulsometer and an MEMS 200 Hz motion sensor (accelerometer, gyroscope, digital compass) and built-in 10 Hz GPS. A sensor was assigned to each player (Polar Pro Team Sensor®) which relayed the data collected during the training sessions by the team's physical fitness coach via Bluetooth to a mobile device (iPad). The RR intervals were stored in the app and were analysed with Fitlab® software (www.HealthSportLab.com; Barcelona, Spain) specifically created to perform HRV studies (Guillaumes et al., 2018). The software filtered out possible recording errors and made it possible to monitor all the players' IL parameters simultaneously in real time. The accelerometer (Boyd et al., 2011) was stored in the app and was analysed with Polar Team Pro® software (https://teampro.polar.com; Kempele, Finland).

Variables studied

The IL variables analysed were: RRmean, SDNN, RMSSD, pNN50, the summated-heart-rate-zones (SHRZ) model and the % summated-heart-rate-zones (%SHRZ) model. The EL variables analysed were: accelerations and decelerations, divided into level 1 accelerations (A-1, between 0.50 m/s^2 and 0.99 m/ s^2), level 2 accelerations (A-2, from 1.00 m/ s^2 to 1.99 m/s^2), level 3 accelerations (A-3, 2.00 m/s^2 to 2.99 m/s^2), level 4 accelerations (A-4, 3.00 m/s^2 to 50.00 m/ s^2); level 1 decelerations (D-1, –0.50 m/s^2 to –0.99 m/s^2), level 2 decelerations (D-2, from –1.00 m/s^2 to –1.99 m s^2), level 3 decelerations (D-3, –2.00 m/s^2 to –2.99 m/s^2), level 4 decelerations (D-4, –3.00 m/s^2 to –50.00 m/s^2), total accelerations (Total_Ac, sum of A-1, A-2, A-3, A-4), and total decelerations (Total_Dec, sum of D-1, D-2, D-3, D-4). Total A-D is the total sum of accelerations and decelerations.

Adapting the classification by Schelling and Torres (2013), the specificity of the exercises was provided for according to levels of approach: level III, IV and V. Provision was also made for half-court (1/2) and full-court (1/1) exercises.

Procedure

A total of 20 training sessions (two weekly sessions for 10 consecutive weeks) were recorded. The recording was divided into two phases: a) continuous recording of HRV for the IL analysis in the course of 10 sessions, both the entire session and on a by-exercise basis, excluding records with artefacts > 15%; b) recording of the accelerometry values for the EL analysis for the subsequent 10 sessions, both the entire session and on a by-exercise basis.

The sensor assigned to the players was fitted before each session following the instructions of the physical fitness coach. The data were recorded individually in simultaneous and synchronised fashion. The team trained three days a week, and the first and second weekly training sessions, which lasted between 75 and 90 minutes, were recorded, beginning with one level III exercise, followed by one or two level IV exercises and with the best part of the training session focusing on level V exercises.

Statistical analysis

The analysis was performed with JASP statistical software, version 9.2.0 (Jasp Team, Amsterdam). A central tendency analysis of the IL, EL and levels of specificity of the training exercises was performed. Taking the non-normality of the sample into account, and with the objective of determining the independence of the variables, the Kruskal-Wallis test was applied to the set of variables pertaining to the training sessions and exercises grouped according to their specificity. The Friedman test was used to evaluate the independence of the variables analysed in the course of the sessions. Subsequently, using the average values of the exercises for which IL and EL variables were available and taking sample size (< 30) into account, Spearman's Rho coefficient was applied to ascertain possible correlations. Finally, taking the normality of these values into account, their possible relationship of dependence was ascertained by means of simple and multiple linear regression analyses. The level of significance for all the analyses is $p < 0.05$. The exact level of significance for each coefficient of correlation is indicated and the values are expressed as the mean ± standard deviation.

Results

In the course of the 10 sessions in the first phase, 145 valid records were obtained for IL from a total of 177. Taking into account their specificity according to the type of exercise for level III, 30 ½ shot records were made in three different sessions; for level IV, four 2x2 ½ records in one session and 33 3x3 Attack-Def-Rest records in three different sessions; for level V, 11 4x4 1/1 records for one session and 67 5x5 1/1 records in five sessions. In the IL descriptive analysis, SHRZ presented the highest average value in 5x5 1/1 (72.10 ± 39.56) and the lowest in ½ shot (12.45 ± 6.09). Similarly, %SHRZ presented the highest average value in 5x5 1/1 (73.17 ± 16.44) and the lowest in ½ shot (48.57 ± 17.86). RRmean behaved in the opposite fashion, with the highest average value in ½ shot (488.07 ± 61.18) and the lowest in 5x5 1/1 (414.84 ± 46.38). SDNN had the highest average value in 2x2 ½ (45.01 ± 13.52) and the lowest in ½ shot (35.46 ± 17.86) (Table 1).

In the course of the 10 second-phase sessions, a total of 171 valid records were obtained for EL. For level III, 23 ½ shot records in one session and 1/1 shot, 10 records in three different sessions; for level IV, 1x1 ½, 18 records in two sessions, 10 2x2 ½ records in one session, 10 3x3 Attack-Def-Rest records in one session and 3x3 ½, 11 records in one session; for level V, 45 4x4 1/1 records over four sessions and 44 5x5 1/1 records in another four. EL presented the highest total Ac-Dec values in 4x4 1/1 (335.31 ± 166.16) and 5x5 1/1 (427.36 ± 235.04) exercises and the lowest values in ½ shot (142.75 ± 31.27) and in 1x1 1/1 (101.20 ± 29.33).

The exercises were distributed in five groups according to their specificity: ½ shot, 2x2 ½, 3x3 1/1 (in its Attack-Defence-Rest variant), 4x4 1/1 and 5x5 1/1. The IL and EL variables behaved independently. There were significant differences between the different exercises analysed according to specificity for the SHRZ ($W = 146.50$; $p = <.001$) and RRmean ($W = 88.45$; $p = <.001$) parameters of IL and for the Total Ac-Dec EL parameter ($W = 94.77$; $p = <.001$). Significant differences were observed between the set of IL

Table 1
Internal variables (mean and SD) recorded in the training sessions according to level of approach (based on Schelling & Torres, 2013) and exercise for 12 amateur basketball players (n=145).

Levels of approach	Number of records	RRmean	SDNN	RMSSD	pNN50	SHRZ	%SHRZ
	n	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Level 3 Directed							
½ shot	30	488.07 ± 61.18	35.46 ± 17.86	7.69 ± 5.27	.47 ± 1.75	12.45 ± 6.09	48.57 ± 17.86
Level 4 Special							
2x2 1/2	4	487.74 ± 65.13	45.01 ± 13.52	8.29 ± 3.81	.16 ± .27	13.83 ± 4.36	49.33 ± 15.31
3x3 1/1 At Def Rest	33	422.88 ± 38.30	37.94 ± 15.91	6.69 ± 2.55	.20 ± .29	14.36 ± 8.02	69.78 ± 14.32
Level 5 Competitive							
4x4 1/1	11	422.99 ± 45.90	42.85 ± 10.04	6.32 ± 2.59	.12 ± .13	53.95 ± 13.20	70.13 ± 14.05
5x5 1/1	67	414.84 ± 46.38	43.49 ± 19.16	7.94 ± 5.79	.33 ± .54	72.10 ± 39.56	73.17 ± 16.44

values of the exercises grouped according to their specificity ($F=28.18$; $p<.001$) and sessions ($F=10.44$; $p<.001$) and of EL values between the exercises grouped according to their specificity ($F=50.74$; $p<.001$) and sessions ($F=24.52$; $p<.001$).

As for the relationships between IL and EL values corresponding to the exercises depending on their specificity, significant correlations were observed between SDNN and Total Ac-Dec (rho = .786; $p=.0048$) as well as between SHRZ and specificity (rho = .893; $p=.012$).

Table 2
Accelerations and decelerations (mean and SD) recorded in the training sessions according to level of approach (based on Schelling & Torres, 2013), intensity and exercise for 12 amateur basketball players (n=171).

Levels of approach	Number of records	A-1	A-2	A-3	A-4	D-1	D-2
	n	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Level 3 Directed							
½ shot	23	28.13 ± 4.39	41.25 ± 7.42	4.0 ± 1.93	.00 ± .00	24.75 ± 4.92	34.00 ± 6.82
1/1 shot	10	51.32 ± 36.04	66.95 ± 50.33	13.95 ± 14.87	.09 ± .29	52.59 ± 37.22	65.77 ± 49.84
Level 4 Special							
1x1 1/1	18	17.10 ± 5.40	26.10 ± 5.04	7.60 ± 3.75	.00 ± .00	17.10 ± 4.65	24.70 ± 5.76
2x2 1/2	10	41.60 ± 8.90	57.60 ± 7.09	14.20 ± 5.53	.00 ± .00	44.0 ± 7.07	53.90 ± 7.29
3x3 1/1	11	32.0 ± 6.03	50.73 ± 10.76	16.82 ± 7.47	.00 ± .00	31.45 ± 9.08	53.00 ± 9.26
3x3 1/1 At Def Rest	10	31.0 ± 7.32	45.90 ± 9.59	15.90 ± 5.55	.00 ± .00	35.30 ± 7.30	47.20 ± 6.27
Level 5 Competitive							
4x4 1/1	45	59.84 ± 30.23	84.78 ± 40.37	20.79 ± 12.19	.05 ± .22	61.02 ± 28.47	83.40 ± 38.79
5x5 1/1	44	75.97 ± 41.14	105.99 ± 54.39	28.91 ± 20.19	.23 ± .84	78.84 ± 45.22	103.48 ± 50.53

Table 2 *(continued)*
Accelerations and decelerations (mean and SD) recorded in the training sessions according to level of approach (based on Schelling & Torres, 2013), intensity and exercise for 12 amateur basketball players.

Levels of approach	No. of records	D-3	D-4	Total Ac	Total Dec	Total Ac-Dec
	n	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Level 3 Directed						
½ shot	23	9.88 ± 5.08	.75 ± .71	73.38 ± 13.14	69.38 ± 17.54	142.75 ± 31.27
1/1 shot	10	15.27 ± 12.98	2.68 ± 3.90	132.32 ± 101.54	136.32 ± 103.94	268.64 ± 205.48
Level 4 Special						
1x1 1/1	18	5.70 ± 2.54	2.90 ± 2.18	50.80 ± 14.20	50.40 ± 15.13	101.20 ± 29.33
2x2 1/2	10	14.70 ± 4.42	2.70 ± 2.50	113.40 ± 21.52	115.30 ± 21.29	228.70 ± 42.81
3x3 1/1	11	14.45 ± 6.68	4.91 ± 2.12	99.55 ± 24.26	103.82 ± 27.15	203.36 ± 51.41
3x3 1/1 At Def Rest	10	13.10 ± 2.96	4.30 ± 3.47	92.80 ± 22.45	99.90 ± 20.00	192.70 ± 42.45
Level 5 Competitive						
4x4 1/1	45	21.40 ± 11.53	4.04 ± 4.36	165.45 ± 83.01	169.86 ± 83.15	335.31 ± 166.16
5x5 1/1	44	28.25 ± 17.86	5.71 ± 4.98	211.09 ± 116.56	216.28 ± 118.49	427.36 ± 235.04

Table 3
Results of the multiple linear regression analysis that accounts for RRMean (IL) according to total accelerations and decelerations (EL).

Regression model summary

Model	R	R^2	Adjusted R^2	RMSE
1	.92	.84	.77	30.30

Predictive variables: Tot_AC, Tot_DEC
Dependent variable: RRmean

ANOVA of the equation

Model	Sum of squares	df	Mean squares	F	p
1 Regression	20356	2	10177.8	11.09	.02
Residual	3671	4	917.8		
Total	24027	6			

Model 1 includes Tot_AC and Tot_DEC

Coefficients of the equation

Model	Non-standardised	Standard Error	Standardised	t	p
1 (Intercept)	492.30	13.12		37.51	< .001
Tot_Ac	6.33	2.40	10.70	2.63	.05
Tot_Dec	-6.53	2.34	-11.46	-2.79	.04

Table 4
Results of the simple linear regression analysis that accounts for %SHRZ (IL) according to exercise specificity (EL).

Regression model summary				
Model	R	R^2	Adjusted R^2	RMSE
1	.77	.59	.51	8.89
Predictive variable: specificity of the exercise Dependent variable: %SHRZ				

ANOVA of the equation					
Model	Sum of squares	df	Mean squares	F	p
1 Regression	593.3	1	593.31	7.35	.04
Residual	403.4	5	80.68		
Total	996.7	6			

Coefficients of the equation					
Model	Non-standardised	Standard Error	Standardised	t	p
1 (Intercept)	40.30	7.59		5.30	.003
Specificity of the exercise	4.60	1.69	.77	2.71	.04

A multiple regression analysis showed that RRmean (IL) is caused by a linear combination of EL variables: Total_Ac and Total_Dec ($R^2 = .84$) (Table 3). In turn, a simple linear regression analysis showed that the behaviour of %SHRZ (IL) was caused by the specificity of the exercises ($R^2 = .59$) (Table 4).

Discussion

The most important finding of this research is the relationship between the IL and EL variables and the specificity of training exercises in men's amateur basketball. IL and EL are different constructs and must be assessed independently (Impellezzeri et al., 2019), suggesting a possible individual regulation of the required IL values according to their relationships with EL and the specificity of the training exercises.

Being able to determine relationships between the IL and EL variables may help to understand the effect of EL on the player and how it affects their recovery, stress or accumulated fatigue (Sansonea et al; 2019). The results obtained in this study point in this direction. In a multifactorial sports context (Carey et al., 2016), the SDNN parameter has evinced a significant correlation with Total Ac_Dec ($p < .05$) which could offer an initial vision of the overall effect of EL on fatigue. The significant relationships found between other variables could open up two channels of action. On the one hand, the possible justification of IL (RRmean) based on the linear combination of Total_Ac and Total_Dec ($R^2 = .84$) would offer a fatigue indicator (Pyne & Martin, 2011) which would make it possible to design specific recovery guidelines for individual profiles (Guillaumes et al., 2018). On the other hand, using a specific IL variable for basketball (Scanlan et al., 2014) such as the %SHRZ ($R^2 = .59$) would make it possible to quantify training exercises and sessions (Sanchez-Ballesta et al., 2019), enabling qualitative (Gabbett, 2016) and preventive (Carey et al., 2016) programming during the season.

Workload management, involving assessing IL and adapting EL to it, is based on the relationship between psychological stress and the exercises performed during training (Scanlan et al., 2014). In the relationship between SHRZ and type of exercise (Rho = .89; $p = .01$), the complexity of the exercise (defined according to the levels of approach

of Schelling and Torres, 2013) and the existing constraints (Balague et al., 2014) come into play. Using the exercises' SHRZ values, the behavioural aspect can be modulated (Capdevila et al., 2008) and integrated into the training with the medium- and long-term objective of improving sports performance, avoiding the monotonous nature of loads (Morales et al., 2019) and cognitive-emotional stimuli.

One necessary premise for assessing the applicability of this approach is the independence of the exercises with respect to the session overall and in relation to the IL and EL variables. These results indicate that the variables do not correspond to a specific pattern with regard to the set of exercises that define the training session, while each level of approach is also specific in behaviour for both EL and IL.

This study presents certain limitations. The use of a particular type of technology did not allow connecting several devices at the same time, meaning that it was not possible to record the IL and EL of each exercise in the same session. In turn, the sports setting is open and complex and contact sports such as basketball usually involve uncontrolled variables that increase recording errors or losses, thus reducing study sample sizes. In this regard, amateur sport affects consistency in terms of players' attendance at training sessions and competitions.

Conclusions

In the specific context of an amateur men's basketball team, significant relationships between IL (RRMean, SDNN and %SHRZ) and EL (Total_Dec) and the specificity of the training exercises were observed. In intermittent load sports such as basketball, the recommendation is that IL and EL be assessed independently and in a complementary fashion.

Practical applications

The levels of approach proposed by Schelling and Torres (2013) constitute a valid tool for managing internal and external load control during training. Their applicability may address two objectives. Firstly, programming using EL values would make it possible to approach required IL values. Moreover, the analysis of the IL values prior to training based on HRV would offer individualised, specific and applicable information for managing the optimal EL for training depending on the player's psychological and physiological status.

Acknowledgements

This study was performed thanks to the I+D+I, DEP2015-68538-C2-1-R project of the Ministry of Economy, Industry and Competitiveness.

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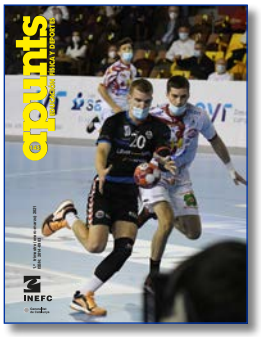
Conflict of Interests: No conflict of interest was reported by the authors.

apunts
EDUCACIÓN FÍSICA Y DEPORTES
ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.07



OPEN ACCESS

Legislative Analysis of Mountaineering and Climbing Technical Qualifications in Spain

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Cite this article:
Sans Osanz, J., & Inglés Yuba, E. (2021). Legislative Analysis of Mountaineering and Climbing Technical Qualifications in Spain. *Apunts. Educación Física y Deportes*, *143*, 52-72. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.07

Editor:

ISSN: 2014-0983

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Section:
Sport Management, Active Leisure and Tourism

Original language:
Spanish

Received:
9 March 2020

Accepted:
7 July 2020

Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

Previous research shows an increase in practitioners of outdoor sports, a rise in companies and professionals working in this field and the need to train qualified instructors. The training system for professionals in the sector is still being organised and the qualifications required to work as an instructor are currently being defined. Royal Decree 318/2000 of 3 March established the qualifications for mountaineering and climbing sports and some autonomous communities (Spain's regions) drew up their own specific syllabuses. Over the following twenty years, the new teaching content was implemented and taught. Royal Decrees 701/2019 and 702/2019, both of 29 November, were published on 10 January 2020 and updated these qualifications. The texts of the previously applicable regulations and the ones recently published concerning the technical qualifications required for these specialities were systematically and exhaustively analysed. The analysis of the regulations in force until 2019 indicated that they varied in the autonomous communities in comparison with the state-wide regulations in key issues: total study load, professional skills, professional practise, training modules completed, time distribution and proportion of hours of theory and practice. Thus with a view to ensuring common and state-wide guidelines for practising as a professional in these specialities, there is an evident need for consensus and homogenisation of the regulations governing qualifications across the autonomous communities. The new qualifications that emerged through the publication of the new decrees address some of these aspects, although they also give rise to other questions and potential issues.

Keywords: sports instructors, outdoor sports, mountaineering and climbing sports, professional qualifications, legal system.

Introduction

Some years ago, there was talk of a boom in what is called outdoor sports and physical activities (OSPA), of a progressive increase in the number of practitioners and a greater number of professionals engaged in this activity (Camps et al., 1995, p. 44). The number of active tourism companies has also burgeoned over the last two decades (Nasarre, 2016, p. 102). The outdoors has become a sports setting that anyone can use; in turn, accidents have increased (Inglés & Seguí, 2012b, p. 89). Numerous studies have provided data about the rising accident rate in mountaineering activities in Spain and other countries (Avellanas, 1995; Nerín & Morandeira, 2005; Powel, 2007; Wild, 2008; Vela, 2009; Mediavilla & Villota, 2012; Sánchez, 2016; FEDME, 2017; Departamento de Interior de la Generalidad de Cataluña, 2019). Despite the existence of regulations governing the responsibility of the stakeholders involved in the activity, the professional setting and qualifications (Inglés & Seguí, 2012b), it would seem that "the legal system is still an unknown quantity in the sector" (Inglés & Seguí, 2012b, p. 90).

The qualifications of sports instructor and higher sports instructor (SI and HSI) were integrated into the education system by means of Royal Decree 1913/1997, subsequently repealed by Royal Decree 1363/2007 when these qualifications went on to become known as *enseñanzas deportivas de régimen especial* (special-regime sports education; SRSE). The SI and HSI qualifications in mountaineering and climbing sports were established by Royal Decree 318/2000 (RD318/2000), which required the autonomous communities (AC) to draw up their own syllabuses based on the observance of minimum content (MC). The implementation of the aforementioned SRSE was described as slow, complex, somewhat heterogeneous and insufficient to meet demand, since it was conducted differently in the AC and in different teaching centre models (Madrera et al., 2014). In 2005, the training range in OSPA was described as highly varied and a degree of confusion was reported with regard to the competencies taught in each training course (Sáez & Giménez, 2005). There is a very close link between SRSE and the professional sphere and the planning of professional venues (Madrera, et al., 2015) and while great progress has been made since the beginning, the qualifications required to work as an OSPA instructor "are still in the resolution stage" (Inglés & Seguí, 2012a, p. 188). Moreover, these activities have a constant creation cycle and evolve by merging or mixing with each other, meaning that regulations rapidly become obsolete (Mediavilla, 2014). Royal Decrees 701/2019 and 702/2019 (RD701/2019 and RD702/2019, respectively) were published in January 2020. These decrees propose substantial changes in the structure, competencies and syllabuses of technical training in the mountaineering and climbing specialities, repealing RD318/2000 and all the other provisions of the same or lower rank which conflict with the new regulation (single repealing provision of RD701/2019 and RD702/2019). New syllabuses for these teaching contents must be implemented as of the 2020/2021 academic year (third final provision, RD701/2019 and RD702/2019) and the educational administrations of the AC must establish the corresponding syllabuses (art. 15, RD701/2019; art. 28, RD702/2019). Until these new syllabuses have been implemented, the teaching contents envisaged by RD318/2000 and those provided for in the regulations brought in by the AC will continue to apply.

There are studies addressing the training of sports instructors in general (García, 2002; González, 2011; Instituto Nacional de las Cualificaciones and Consejo Superior de Deportes, 2007; Projet Vocasport, 2004) as well as analysis of the applicable Spanish legal system for active tourism (Nasarre, 2000, 2008; Inglés & Seguí, 2012a; Bonnet et al., 2018). Even so, the status of sports instructors, their conditions of employment and the prevailing scenario with regard to the regulation of what they teach is under-addressed in the literature (García, 2002) and for the moment there is a shortage of research analysing contents, specific competencies and syllabuses in the legislative texts concerning the OSPA instructor qualification.

Exhaustive assessment of the current situation of technical training in OSPA is warranted on account of the increased number of practitioners and sportspersons, the need to train professionals, the growing number of SRSE students, its uneven implementation and the new legislation enacted.

This context provides the rationale for this article, which sets out to analyse and compare the state-wide regulations to the regulatory developments in the AC in SI and HSI qualifications in the mountaineering and climbing sports speciality by analysing both the previous syllabuses and the new ones.

Methodology

Systematic and exhaustive analysis was performed of the content of the state-wide regulations and the corresponding regulations implemented by the AC governing qualifications in SI and HSI for mountaineering and climbing sports that were applicable until 2019 as well as of the regulations for the new qualifications. Table 1 details the state-wide regulatory framework analysed along with the corresponding regulatory implementation enacted by the AC to establish the relevant syllabuses (cells with a diagonal line through them denote the absence of any regulation).

Table 1
State-wide regulatory framework and regulatory implementation by the AC with regard to the sports instructor and higher sports instructor qualifications in the mountaineering and climbing sports speciality.

	SI1	SI2				HSI		
		High Mountain	Walk-up	Canyons	Climbing	High Mountain	Climbing	Ski Mountaineering
ARAGON	Order of 22 September 2006, by the Department of Education, Culture and Sports, establishing the syllabuses and specific examinations for access to the sports instructor qualifications in the Mountaineering and Climbing specialities in the Autonomous Community of Aragon					Order of 26 April 2002, by the Department of Education and Science, establishing, experimentally, the syllabuses and specific examinations for access to the sports instructor and higher sports instructor qualifications in the Mountaineering and Climbing specialities in the Autonomous Community of Aragon		
CATALONIA	Decree 243/2003 of 8 October, establishing the syllabuses and regulating the specific examinations for access to the sports instructor qualifications in the following mountaineering and climbing sport specialities: high mountain, canyoning, climbing and mountaineering							
AUTONOMOUS COMMUNITY OF MADRID	Order 3198/2003 of 11 June, of the Autonomous Department of Education, establishing the syllabuses and the specific examinations for access to the courses of education for obtaining the Sports Instructor and Higher Sports Instructor qualifications in the Mountaineering and Climbing sports specialities Order 3694/2009, of 28 July, establishing, for the Autonomous Community of Madrid, the time distribution of Special-Regime Sports Education in Athletics, Basketball, Handball, Winter Sports, Mountaineering Sports and Climbing and Football							
ANDALUSIA	Decree 169/2006 of 26 September, establishing the syllabuses, requirements and specific examinations for access to the Sports Instructor qualifications in the mountaineering and climbing sports specialities and Higher Sports Instructor in the mountaineering and climbing sports specialities							
ASTURIAS	Decree 88/2005 of 3 August, establishing the syllabuses and regulating the specific examinations and requirements for access to the courses for obtaining the qualifications of Sports Instructor and Higher Sports Instructor in the specialities of Mountaineering and Climbing Sports in Asturias							
BASQUE COUNTRY	Decree 173/2010 of 29 June, establishing the syllabus corresponding to the courses of education of Sports Instructor and Higher Sports Instructor in the specialities of Mountaineering and Climbing Sports and governing the corresponding examinations and access requirements							
CANTABRIA	Order ECD/7/2012 of 3 February, establishing the syllabuses and regulating the specific access examinations and sports requirements for obtaining the Sports Instructor and Higher Sports Instructor qualifications in the specialities of Mountaineering and Climbing Sports in the Autonomous Community of Cantabria							
BALEARICS	Decree 104/2006 of 7 December 2006, establishing the syllabuses, examinations and access requirements for obtaining the Sports Instructor and Higher Sports Instructor qualifications in the specialities of Mountaineering and Climbing Sports	Decree 104/2006 of 7 December 2006, establishing the syllabuses, examinations and access requirements for obtaining the Sports Instructor and Higher Sports Instructor qualifications in the specialities of Mountaineering and Climbing Sports				Decree 104/2006 of 7 December 2006, establishing the syllabuses, examinations and access requirements for obtaining the Sports Instructor and Higher Sports Instructor qualifications in the specialities of Mountaineering and Climbing Sports		

Source: own compilation

Table 1 *(continuation)*
State-wide regulatory framework and regulatory implementation by the AC with regard to the sports instructor and higher sports instructor qualifications in the mountaineering and climbing sports speciality.

	SI1	SI2				HSI		
		High Mountain	Walk-up	Canyons	Climbing	High Mountain	Climbing	Ski Mountaineering
AUTONOMOUS COMMUNITY OF NAVARRA	Autonomous Decree 110/2014 of 19 November, establishing the structure and the syllabus of the sports instructor qualification in walk-up for special-regime sports education in the Autonomous Community of Community of Navarra		Autonomous Decree 110/2014 of 19 November, establishing the structure and the syllabus of the sports instructor qualification in walk-up for special-regime sports education in the Autonomous Community of Navarra		Autonomous Decree 100/2017 of 8 November, establishing the structure and the syllabus of the sports instructor qualification in climbing for special-regime sports education in the Autonomous Community of Navarra			
TERRITORIES DIRECTLY MANAGED BY THE MINISTRY	Order ECI/858/2005 of 28 March, establishing, for the territorial sphere under the direct management of the Ministry of Education and Science, the syllabuses and the examinations and access requirements corresponding to the Sports Instructor and Higher Sports Instructor qualifications in Mountaineering and Climbing Sports							
EXTREMADURA								
THE CANARIES								
CASTILE AND LEÓN								
CASTILE LA MANCHA								
MURCIA								
VALENCIAN COMMUNITY								
GALICIA								
LA RIOJA								
STATE-WIDE LEGISLATION	Royal Decree 318/2000 of 3 March, establishing the Sports Instructor and Higher Sports Instructor qualifications in the specialities of Mountaineering and Climbing Sports, approving the corresponding minimum content content and regulating the examinations for access to these courses (in force until 2019) Royal Decree 701/2019 of 29 November, establishing the Higher Sports Instructor qualifications in High Mountaineering and Higher Sports Instructor in Climbing and setting the core syllabuses and access requirements Royal Decree 702/2019 of 29 November, establishing the qualifications for Sports Instructor in Canyoning, Sports Instructor in Climbing and Sports Instructor in Walk-up and setting the core syllabuses and access requirements							

Source: own compilation

Results

1. Identification of the qualifications, organisation of teaching and equivalences between qualifications

In the qualifications in force until 2019, all the AC regulations were limited to the two-degree and three-training-level structure provided for by the state-wide regulations. Nevertheless, different names were sometimes given to the same qualification: *certificado de primer nivel de técnico deportivo* [first-level sports instructor certificate] (SI1). This was known as *primer nivel de excursionismo* [first-level hiking] (Catalonia), *certificado de iniciador de montañismo* [mountaineering introduction certificate] (Asturias) and *primer nivel de TD en media montaña* [first level higher instructor in walk-up] (Navarra) to name but a few. The new and currently applicable RD702/2019 proposes standardisation under the name of *ciclo inicial de grado medio en senderismo* [Initial vocational training in hill walking] (IVTWalking); as yet, it is unknown whether this name will be universally adopted until the AC have developed their own syllabuses.

The new teaching courses have dispensed with the high mountain SI and the ski mountaineering HSI, providing solely the IVTWalking, medium-level vocational training in hill-walking, climbing and walk-up (MLVTCanyons, MLVTClimbing and MLVTWalk-up, respectively) and advanced vocational training in climbing and high mountain (AVTClimbing and AVTHigh).

It should be noted that the new regulations provide for specialisations within each qualification (Table 3), although the objectives, content and evaluation criteria have not yet been established.

Table 2
Organisation of teaching courses in force between 2000 and 2019.

Organisation of previous teaching courses (RD318/2000)		
SI1 HIKING	SI2 CANYONING	-
	SI2 CLIMBING	HSI CLIMBING
	SI2 WALK-UP	-
	SI2 HIGH MOUNTAIN	HSI SKI MOUNTAINEERING HSI HIGH MOUNTAIN

Source: own compilation based on the regulations analysed

Table 3
Organisation of the new teaching courses: vocational training and specialisations by type.

Organisation of new teaching courses (RD701/2019 and RD702/2019)		
IVT HILL WALKING	MLVT CANYONS a) Path marking b) Adapted canyoning c) Interpretation of the environment d) Interpretation of natural heritage e) New trends in canyoning	-
	MLVT CLIMBING a) Path marking b) Climbing guide c) Interpretation of the environment d) Interpretation of natural heritage e) Rock climbing f) Indoor climbing	AVT CLIMBING a) Adapted climbing
	MLVT WALK-UP a) Path marking b) Interpretation of the environment c) Interpretation of natural heritage d) Nordic walking e) Adapted walk-up f) Mountain survival	AVT HIGH MOUNTAIN a) Adapted high mountain b) High mountain guide

Source: own compilation based on the regulations analysed

With regard to the equivalences between qualifications, SI1 is equivalent to IVTWalking; the previous second-level SI qualifications (SI2) are equivalent to the new MLVT (except the high-mountain SI2, which no longer exists) and the previous higher sports instructor (HSI) qualifications are equivalent to the new AVT (except for the ski mountaineering HSI, which no longer exists). Any person already qualified will enjoy the same professional and academic effects that are provided for in the new legislation (third additional provision of RD701/2019; fourth additional provision of RD702/2019). Now that the high-mountain SI2 no longer exists, two qualifications (MLVT climbing and MLVT walk-up) or the former high-mountain SI2 will now be necessary to be eligible for the new High Mountain AVT.

It does not clarify where the qualifications that no longer exist (high-mountain SI2 and ski mountaineering HSI) fit into the professional sphere.

2. Professional profile

With regard to the qualifications effective up until 2019, the professional profile was established on the basis of competencies, professional skills, location in the sports field and responsibility in work situations. The regulations of the AC and the RD318/2000 were analysed, it transpiring that the structure presented overlapping and on occasions contradictory information in different sections: for example, for the climbing SI2, the possibility of practising on "difficult" routes up to 3500 m (Annex III, 4.4 of RD318/2000) whereas in another part of the text, "very difficult" routes of up to 3500 m were cited too (Annex III, 4.3 of RD318/2000).

The analysis of the SI1 professional profile showed that the Basque Country, Catalonia, Aragon and Navarra did not textually cite the units of competency and professional skills of the state-wide regulation, using different wordings and/or additions (pertaining to gender equality, the promotion of hiking activities, informing about the characteristics of the route and the area, natural values, environmental protection regulations, the necessary equipment, etc.).

The analysis of the SI2 yielded differences in the wording and the units of competency and professional skills added and/or removed from the state-wide regulation.

For example, Catalonia added SI2 high-mountain competencies that did not appear in the state-wide regulations with regard to informing the group about the scheduled route using maps, providing information about nature and culture, suitable equipment and maintenance and other points. It was the only AC which specified, for the walk-up SI2, the possibility of engaging in high-mountain activities in summer (Annex 6, 3; Decree 243/2003), a competency not provided for in RD318/2000. Mention should be made of the inconsistency in the type of canyon where the SI2 qualification could be used; only Andalusia and Aragon provided for practice in horizontal and dry canyons, whereas Catalonia also provided for practice on low ground, walk-up and unspecified terrain. The new legislation clarifies this point by explicitly referring to competency in dry and water canyons.

A lack of terminological consistency was also observed, since certain AC used both the "*excursionismo*" [hiking] and "*senderismo*" [hill-walking/rambling] terms, and some other concepts were not clear either. The new regulations clarify this point by adding a glossary (Annex I, RD702/2019).

The HSI analysis showed a textual citation of the units of competency and professional skills (except for Andalusia, removing the professional skill pertaining to the design, planning and management of ski mountaineering competitions).

The new qualifications define professional profile on the basis of general competency and professional, personal and social competencies. Relevant changes of competencies are made; previously holders of the SI1 could not practise without the supervision of an SI or HSI whereas the new legislation dispenses with this restriction. Now, a person holding the IVTWalking qualification can cooperate in controlling safety in adventure parks in trees or artificial structures and can also facilitate free-time and environmental education activities.

The MLVTCanyons takes on greater competencies such as the design and installation of equipment in canyoning itineraries, equipped via ferratas and adventure parks, the design of hill-walking teaching programmes, progression, orientation in delimited natural spaces, camping and introduction to climbing.

The former climbing SI2 was qualified to guide in non-equipped via ferratas, clear or adventure terrain, whereas the new MLVTClimbing loses this competency; however, they are qualified to equip and secure controlled adventure spaces, equip or re-equip rock-climbing routes and design climbing itineraries for climbing walls or artificial structures.

Unlike the previous regulation, a person holding an MLVTCanyons and/or MLVTClimbing qualification will now be able to operate as a guide in low-mountain and walk-up activities in summer and equipped via ferratas (the level of difficulty is not specified). The three MLVT qualifications will be entitled to monitor safety in adventure parks and trees and will be able to facilitate and organise free-time activities within the general programming of hill-walking and walk-up activities in summer.

In accordance with the foregoing, a person holding the previous SI2 climbing qualification will now automatically have the new competencies of the new qualification without actually having studied them (for example, low-mountain and walk-up guides in summer, via ferratas, etc.) and will

also retain the previous qualifications, meaning that a person qualified according to the previous syllabus now has more competencies.

Unlike the previous qualifications in HSI, the AVTHigh clarifies competencies in ice climbing and the training of mountaineering and climbing instructors, whereas the AVTClimbing clarifies competencies in designing and equipping climbing routes (high difficulty).

3. Professional, occupational and sports environment

Previous qualifications specified the type of organisations in which it was possible to practise. In this regard, differences were also observed between the AC: five of them provided for the possibility of practising in the areas of free-time, leisure and active tourism, for which no provision whatsoever was made in the state-wide regulations. The new legislation remedies this heterogeneity by stipulating the sectors pertaining to sport, leisure, free-time and tourism and also detailing where they can be practised (for example, rural accommodation, campsites, hostels, etc.).

The previous qualifications did not detail the main activities that could be carried out; only Catalonia did so. The new legislation does establish the most relevant jobs for each qualification (Table 4).

4. Total teaching time. Time distribution

With regard to the above qualifications, the total teaching time provided for by the state-wide regulations and the corresponding AC regulatory developments was analysed. Heterogeneity was found for the same levels, meaning that the time required to obtain the same qualification could be lower or higher depending on the AC (in bold in Table 5). The total duration envisioned by the new legislation was also included, showing a marked increase in teaching hours in comparison with the previous qualifications.

The modules established by the AC for the same qualification were also different in terms of time distribution. To demonstrate this, the difference, in terms of modules and blocks, between the times provided for in each AC's regulatory development and those provided for in the MC of RD318/2000 was used (Tables 6, 7 and 8). Certain AC

Table 4
Most relevant activities and jobs for each new qualification.

	Most relevant activities and jobs
IVTWalking	a) Guide on low-mountain routes and delimited natural spaces, adventure parks in trees or artificial structures b) Operator in adventure parks in trees or artificial structures
MLVTCanyons	a) Canyon guide b) Summer walk-up guide c) Safety control in adventure parks in trees or artificial structures
MLVTClimbing	a) Climbing instructor b) Climbing school director c) Summer walk-up guide d) Equipped and semi-equipped via ferrata climbing guide e) Safety control in adventure parks in trees or artificial structures
MLVTWalk-up	a) Low-mountain, walk-up and Nordic-type snow-covered ground guide b) Trainer in beginners' and advanced mountaineering sports c) Safety control in adventure parks in trees or artificial structures
AVTClimbing	a) Climbing instructor b) Climbing school teacher c) Technical director d) Trainer of medium- and higher-level climbing instructors e) Climbing centre manager f) Event organiser in the speciality
AVTHigh	a) High-mountain guide b) High-mountain school teacher c) Mountaineering instructor d) Trainer of medium- and higher-level instructors e) Mountaineering school manager f) High-mountain activities organiser g) Technical director

Source: own compilation based on the regulations

Table 5
Comparison of the total duration of teaching courses in force until 2019 as established by RD318/2000 and by the regulatory implementation of each AC and total duration of the new qualifications.

	Qualifications in force until 2019							
		SI2				HSI		
	SI1	High mountain	Walk-up	Canyons	Climbing	High mountain	Climbing	Ski mountaineering
RD318/2000	420	680	555	555	630	755	755	755
ARAGON	420	680	555	555	630	755	710	710
CATALONIA	420	680	555	555	630			
AUTONOMOUS COMMUNITY OF MADRID	420	680	555	555	630	755	755	755
ANDALUSIA	420	680	555	555	630	780	780	780
ASTURIAS	420	680	555	555	630	755	755	755
BASQUE COUNTRY	450	930	615	600	680	735	650	650
CANTABRIA	420	680	555	555	630	755	755	755
BALEARICS	420		555	555	630		755	
NAVARRA	450		630		670			
ECI/858/2005	420	680	555	555	630	755	755	755
	New qualifications							
		MLVT				AVT		
	IVTWalking		Walk-up	Canyons	Climbing	High mountain	Climbing	
RD702/2019 and RD701/2019	570		690	870	1005	1175	885	

Source: own compilation based on the regulations analysed.

Table 6
Previous teaching: time distribution, difference with MC. Level: SI1.

	SI1 of mountaineering and climbing sports																					
Minimum content (hours) and difference (hours) between the AC and the MC	MC		ARAGON		CATALONIA		AUTONO-MOUS COMMUNITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		BALEARICS		A.C. NAVARRA		ECI/858	
	hours		Difference (hours)																			
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
The anatomical and physiological basics of sport	15	0	5	0	5	0	25	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0
The psycho-pedagogical basics of teaching and sports training	10	0	5	5	15	0	5	5	0	5	5	5	0	5	0	5	0	5	0	5	0	5
Sports training	10	5	5	0	10	5	0	10	5	10	0	5	5	5	0	5	0	5	5	5	0	5
The sociological basics of sport	5	0	0	0	0	0	5	0	10	0	5	0	0	0	0	0	0	0	0	0	0	0
Sports organisation and legislation	5	0	0	0	0	0	5	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0
First aid and hygiene in sports	10	5	10	5	15	5	5	15	0	5	15	10	30	5	20	10	20	10	30	5	20	10
Teaching time per block	55	10	25	10	45	10	45	30	25	30	30	20	35	15	20	20	20	20	35	15	20	20
	65		35		55		75		55		50		50		40		40		50		40	
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Professional development	5	0	0	0	5	0	5	0	0	0	5	0	15	0	5	5	5	0	10	0	0	0
Technical training in mountaineering	15	20	0	40	10	0	5	30	0	30	5	15	0	40	10	10	5	30	10	35	0	40
The mountain environment	5	5	10	5	25	5	5	15	0	15	5	10	0	15	15	10	0	15	5	5	0	15
Mountaineering safety	10	10	0	10	0	0	-5	15	5	10	5	10	0	15	10	5	5	10	5	15	0	15
Group didactics and dynamics					10	10																
Teaching time per block	35	35	10	55	50	15	10	60	5	55	20	35	15	70	40	30	15	55	30	55	0	70
	70		65		65		70		60		55		85		70		70		85		70	
Complementary Block	15		20		0		5		5		15		15		10		10		15		10	
Practical Training Block	80		70		70		50		70		70		70		70		70		70		70	
Total Teaching time	230		190		190		190		190		190		220		190		190		220		190	

Source: own compilation based on the regulations

Table 7
Previous teaching courses: time distribution, difference with MC. Level: SI2.

Minimum content (hours) and difference (hours) between the AC and the MC	SI2 High Mountain																					
	MC		ARAGON		CATALONIA		AUTO-NOMOUS COMMU-NITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		BALEARICS		A.C. NAVARRA		ECI/858	
	hours		Difference (hours)																			
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
The anatomical and physiological basics of sport II	25	0	5	5	15	0	0	20	0	10	0	5	5	5	0	5					0	5
The psycho-pedagogical basics of teaching and training II	15	0	5	5	30	0	5	10	10	10	0	5	5	5	0	5					0	5
Sports training II	15	10	5	5	15	0	0	20	5	10	0	5	15	5	0	5					0	5
Sports organisation and legislation II	5	0	0	0	0	0	10	0	5	0	5	0	0	0	0	0					0	0
Sports theory in sociology	10	0	0	0	10	0	5	0	5	0	0	0	0	0	0	0					0	0
Teaching time per block	70	10	15	15	70	0	20	50	25	30	5	15	25	15	0	15					0	15
	80		30		70		70		55		20		40		15						15	
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Leading people in mountaineering and ski mountaineering	5	15	0	85	5	5	0	10	0	10	5	20	5	135	5	25					0	15
Professional development of the instructor of the speciality	5	0	5	0	5	0	10	0	10	0	5	0	5	0	2	10					5	0
Training in climbing and ski mountaineering	5	5	0	5	5	5	0	5	0	0	5	0	0	15	3	15					0	0
Training in mountaineering	5	0	0	5	5	10	0	10	0	5	0	5	0	20	0	5					0	5
Technical training and methodology of mountaineering teaching	5	30	5	20	5	5	5	50	10	50	15	40	5	70	10	30					0	65
Technical training and methodology of ski mountaineering teaching	5	30	5	20	5	5	5	50			10	40	5	70	10	25					0	65
Technical training and methodology of climbing teaching					25	40																
Technical training in mountain progression									10	50												
The mountain environment II	5	10	0	5	5	0	5	10	10	10	10	15	0	15	10	15					0	15
Safety in the sport	5	20	0	20	5	5	10	10	5	20	15	15	5	80	5	20					0	20
The psychology of mountaineering and climbing sports					10	0																
Teaching time per block	40	110	15	160	75	75	35	145	40	115	65	135	25	405	45	145					5	185
	150		175		150		180		155		200		430		190						190	
Complementary Block	25		20		5		5		15		5		5		20						20	
Practical Training Block	110		90		90		60		90		90		90		90						90	
Total teaching time	365		315		315		315		315		315		565		315						315	

Source: own compilation based on the regulations

Table 7 *(continuation)*
Previous teaching courses: time distribution, difference with MC. Level: SI2.

	SI2 walk-up																				
Minimum content (hours) and difference (hours) between the AC and the MC	MC		ARAGON		CATALONIA		AUTO-NOMOUS COMMU-NITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		BALEARICS		A.C. NAVARRA		ECI/858	
	hours		Difference (hours)																			
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P		T	P	T	P
The anatomical and physiological basics of sport II	25	0	5	5	15	0	0	20	0	10	0	5	5	5	0	5	5		5	5	0	5
The psycho-pedagogical basics of teaching and training II	15	0	5	5	30	0	5	10	10	10	0	5	5	5	0	5	5		5	5	0	5
Sports training II	15	10	5	5	15	0	0	20	5	10	0	5	15	5	0	5	5		15	5	0	5
Sports organisation and legislation II	5	0	0	0	0	0	10	0	5	0	5	0	0	0	0	0	0		0	0	0	0
Sports theory and sociology	10	0	0	0	10	0	5	0	5	0	0	0	0	0	0	0	0		0	0	0	0
Teaching time per block	70	10	0	15	70	0	20	50	25	30	5	15	25	15	0	15	15		25	15	0	15
	80		30		70		70		55		20		40		15				40		15	
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P		T	P	T	P
Leading in walk-up	5	15	0	30	0	5	5	5	5	5	5	15	0	20	5	15	5		5	35	0	20
Professional development of the walk-up instructor	5	0	5	0	5	0	10	0	5	0	5	0	5	0	2	10	5		5	0	5	0
Training in mountaineering	5	5	0	0	5	5	0	5	0	0	5	5	0	0	3	5	10		0	0	0	0
Technical training in mountain progression	5	20	0	25	15	15	15	30	10	25	15	35	0	45	15	20	65		10	45	0	45
The mountain environment II	5	10	10	20	5	0	10	20	15	20	10	15	0	50	10	15	10		5	15	0	50
Safety in the sport	5	10	0	20	5	15	15	0	0	5	10	15	5	50	10	15	30		15	55	0	5
The psychology of mountaineering and climbing sports					10	0																
Teaching time per block	30	60	15	95	45	40	55	60	35	55	50	85	10	165	45	80	125		40	150	5	120
	90		110		85		115		90		135		175		125				190		125	
Complementary Block	25		20		5		5		15		5		5		20		20		5		20	
Practical Training Block	110		90		90		60		90		90		90		90		90		90		90	
Total teaching time	305		250		250		250		250		250		310		250		250		325		250	

Source: own compilation based on the regulations

Table 7 *(continuation)*
Previous teaching courses: time distribution, difference with MC. Level: SI2.

	SI2 Canyoning																					
Minimum content (hours) and difference (hours) between the AC and the MC	MC		ARAGON		CATALONIA		AUTO-NOMOUS COMMU-NITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		BALEARICS	A.C. NAVARRA		ECI/858	
	hours		Difference (hours)																			
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P	T	P	T	P
The anatomical and physiological basics of sport II	25	0	5	5	15	0	0	20	0	10	0	5	5	5	0	5	5			0	5
The psycho-pedagogical basics of teaching and training II	15	0	5	5	30	0	5	10	10	10	0	5	5	5	0	5	5			0	5
Sports training II	15	10	5	5	15	0	0	20	5	10	0	5	15	5	0	5	5			0	5
Sports organisation and legislation II	5	0	0	0	0	0	10	0	5	0	5	0	0	0	0	0	0			0	0
Sports theory and sociology	10	0	0	0	10	0	5	0	5	0	0	0	0	0	0	0	0			0	0
Teaching time per block	70	10	15	15	70	0	20	50	25	30	5	15	25	15	0	15	15			0	15
	80		30		70		70		55		20		40		15					15	
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P	T	P	T	P
Leading in canyons	5	10	5	45	5	10	0	15	0	20	5	20	0	30	5	30	10			0	30
Professional development of the instructor of the speciality	5	0	5	0	5	0	10	0	5	0	5	0	5	0	2	10	5			5	0
Canyon descent training	5	5	0	0	0	0	0	5	0	0	5	5	0	10	0	2	0			0	10
Technical training and methodology of canyon descent teaching	5	20	5	35	15	20	20	30	10	30	15	35	0	60	5	35	95			0	60
The canyon environment	10	5	-5	10	0	5	5	10	5	10	5	20	0	10	0	6	10			0	10
Safety in the sport	5	15	0	10	5	10	5	15	0	10	10	10	0	45	5	25	5			0	10
The psychology of mountaineering and climbing sports					10	0															
Teaching time per block	35	55	10	100	40	45	40	75	20	70	45	90	5	155	17	108	125			5	120
	90		110		85		115		90		135		160		125					125	
Complementary Block	25		20		5		5		15		5		5		20		20			20	
Practical Training Block	110		90		90		60		90		90		90		90		90			90	
Total teaching time	305		250		250		250		250		250		295		250		250			250	

Source: own compilation based on the regulations

Table 7 *(continuation)*
Previous teaching courses: time distribution, difference with MC. Level: SI2.

	SI2 Climbing																					
Minimum content (hours) and difference (hours) between the AC and the MC	MC		ARAGON		CATALONIA		AUTO-NOMOUS COMMU-NITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		BALEARICS	A.C. NAVARRA		ECI/858	
	hours		Difference (hours)																		
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P	T	P	T	P
The anatomical and physiological basics of sport II	25	0	5	5	15	0	0	20	0	10	0	5	5	5	0	5	5	5	5	0	5
The psycho-pedagogical basics of teaching and training II	15	0	5	5	30	0	5	10	10	10	0	5	5	5	0	5	5	5	5	0	5
Sports training II	15	10	5	5	15	0	0	20	5	10	0	5	15	5	0	5	5	15	5	0	5
Sports organisation and legislation II	5	0	0	0	0	0	10	0	5	0	5	0	0	0	0	0	0	0	0	0	0
Sports theory and sociology	10	0	0	0	10	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Teaching time per block	70	10	15	15	70	0	20	50	25	30	5	15	25	15	0	15	15	25	15	0	15
	80		30		70		70		55		20		40		15			40		15	
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P	T	P	T	P
Leading in climbing	5	10	5	35	5	15	5	10	0	5	10	35	0	35	10	35	10	5	40	0	35
Professional development of the instructor of the speciality	5	0	5	0	5	0	10	0	10	0	5	0	5	0	2	10	5	5	0	5	0
Climbing training	5	5	0	15	10	30	5	15	0	15	10	5	0	15	10	10	10	0	5	0	15
Technical training and methodology of climbing teaching	5	55	10	55	20	-15	20	55	20	55	25	15	0	75	20	15	105	10	45	0	75
The mountain environment in climbing	10	10	-5	10	0	0	5	5	0	5	5	15	0	5	0	5	5	0	15	0	5
Safety in the sport	5	15	0	15	5	0	5	15	0	15	15	30	0	65	8	35	25	15	50	0	25
Climbing facilities equipment					10	25															
The psychology of mountaineering and climbing sports					10	0															
Teaching time per block	35	95	15	130	65	55	50	100	30	95	70	100	5	195	50	110	160	35	155	5	155
	130		145		120		150		125		170		200		160			190		160	
Complementary Block	25		20		5		5		15		5		5		20		20	5		20	
Practical Training Block	110		90		90		60		90		90		90		90		90	90		90	
Total teaching time	345		285		285		285		285		285		335		285		285	325		285	

Source: own compilation based on the regulations

Table 8
Previous teaching courses: time distribution, difference with MC. Level: HSI.

Minimum content (hours) and difference (hours) between the AC and the MC	HSI High-Mountain																	
	MC		ARAGON		AUTONOMOUS COMMUNITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		BALEARICS		ECI/858	
	hours		difference (hours)															
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
The biomechanics of sport	10	5	0	5	3	2	10	5	0	5	0	5	0	5			0	5
High-performance training	15	15	5	0	2	3	15	10	5	5	5	5	5	5			5	5
The physiology of effort	15	5	5	5	12	3	10	5	5	5	5	5	5	5			5	5
Sports management	25	0	0	0	0	0	5	10	5	5	-5	5	5	5			5	5
High-performance psychology	5	5	10	0	8	7	15	-5	5	0	5	0	5	0			5	0
High-performance sports sociology	10	0	5	5	5	0	10	0	0	5	0	0	0	5			0	5
Teaching time per block	80	30	25	15	30	15	65	25	20	25	10	20	20	25			20	25
	110		40		45		90		45		30		45				45	
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Leading in mountaineering and ski mountaineering II	5	15	5	20	5	20	5	15	5	35	0	60	5	35			0	20
Professional development of the HSI	15	0	15	0	15	0	10	0	0	10	0	0	0	10			10	0
Mountaineering training II	5	10	5	45	20	10	20	10	10	20	0	40	10	20			0	40
Technical training in ski mountaineering II	5	20	0	20	5	20	5	30	20	20	0	30	20	20			0	30
Mountaineering techniques optimisation	15	25	5	25	-5	25	-5	25	10	30	0	25	10	30			0	35
Teaching time per block	45	70	30	110	40	75	35	80	45	115	0	155	45	115			10	125
	115		140		115		115		160		155		160				135	
Complementary Block	40		35		45		35		10		10		10				35	
Practical Training Block	110		90		90		90		90		90		90				90	
Final-year project	40		35		45		35		35		35		35				35	
Total teaching time	415		340		340		365		340		320		340				340	

Source: own compilation based on the regulations

Table 8 *(continuation)*
Previous teaching courses: time distribution, difference with MC. Level: HSI.

Minimum content (hours) and difference (hours) between the AC and the MC	HSI Climbing																
	MC		ARAGON		AUTONOMOUS COMMUNITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		BALEARICS	ECI/858	
	hours		difference (hours)														
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P	T	P
The biomechanics of sport	10	5	0	5	3	2	10	5	0	5	0	5	0	5	5	0	5
High-performance training	15	15	5	0	2	3	15	10	5	5	5	5	5	5	10	5	5
The physiology of effort	15	5	5	5	12	3	10	5	5	5	5	5	5	5	10	5	5
Sports management	25	0	0	0	0	0	5	10	5	5	-5	5	5	5	10	5	5
High-performance psychology	5	5	10	0	8	7	15	-5	5	0	5	0	5	0	5	5	0
High-performance sports sociology	10	0	5	5	5	0	10	0	0	5	0	0	0	5	5	0	5
Teaching time per block	80	30	25	15	30	15	65	25	20	25	10	20	20	25	45	20	25
	110		40		45		90		45		30		45			45	
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P	T	P
Leading in mountaineering and ski mountaineering															5	10	30
Professional development of the HSI	15	0	5	10	20	10	10	20	0	10	0	0	0	10	10	0	10
Climbing training II	25	25	5	45	5	35	10	30	15	60	0	35	15	65	30	0	50
Mountaineering technique optimisation	25	25	5	25	5	40	5	40	20	55	0	35	15	55	95	0	35
Teaching time per block	65	50	15	80	30	85	25	90	35	125	0	70	30	130	135	10	125
	115		95		115		115		160		70		160			135	
Complementary Block	40		35		45		35		10		10		10		35	35	
Practical Training Block	110		90		90		90		90		90		90		90	90	
Final-year project	40		35		45		35		35		35		35		35	35	
Total teaching time	415		295		340		365		340		235		340		340	340	

Source: own compilation based on the regulations

Table 8 *(continuation)*
Previous teaching courses: time distribution, difference with MC. Level: HSI.

Minimum content (hours) and difference (hours) between the AC and the MC	HSI Ski mountaineering																
	MC		ARAGON		AUTONOMOUS COMMUNITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		BALEARICS	ECI/858	
	hours		difference (hours)														
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P	T	P
The biomechanics of sport	10	5	0	5	3	2	10	5	0	5	0	5	0	5		0	5
High-performance training	15	15	5	0	2	3	15	10	5	5	5	5	5	5		5	5
The physiology of effort	15	5	5	5	12	3	10	5	5	5	5	5	5	5		5	5
Sports management	25	0	0	0	0	0	5	10	5	5	-5	5	5	5		5	5
High-performance psychology	5	5	10	0	8	7	15	-5	5	0	5	0	5	0		5	0
High-performance sports sociology	10	0	5	5	5	0	10	0	0	5	0	0	0	5		0	5
Teaching time per block	80	30	25	15	30	15	65	25	20	25	10	20	20	25		20	25
	110		40		45		90		45		30		45			45	
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T&P	T	P
Leading in mountaineering and ski mountaineering II																10	25
Professional development of the HSI	15	0	5	10	20	10	10	20	0	10	0	0	0	10		0	10
Technical training in ski mountaineering II	25	25	5	45	5	35	10	30	15	60	0	35	15	65		0	50
Ski mountaineering technique optimisation	25	25	5	25	5	40	5	40	20	55	0	35	15	55		0	40
Teaching time per block	65	50	15	80	30	85	25	90	35	125	0	70	30	130		10	125
	115		95		115		115		160		70		160			135	
Complementary Block	40		35		45		35		10		10		10			35	
Practical Training Block	110		90		90		90		90		90		90			90	
Final-year project	40		35		125		35		35		35		35			35	
Total teaching time	415		295		340		365		340		235		340			340	

Source: own compilation based on the regulations

allocated times that were well above the MC to their syllabuses, whereas others allocated fewer hours than those provided for in the state-wide regulations. The major differences in the times allocated to the different blocks by the AC are shown below: Common Block, Specific Block, Complementary Block, Practical Training Block and Final-Year Project (hereinafter: CB, SB, ComplB, PTB and FYP, respectively) (Tables 6, 7 and 8).

The new legislation establishes a core syllabus. At the time of writing of this article, no AC had published its own syllabus. It should be mentioned that the new training will be divided solely into CB and SB, meaning a simplification of the previous structure.

5. Teaching modules

For the above qualifications, the differences between the modules established in the AC regulations and those provided for in the state-wide regulations were analysed (RD 318/2000). The state-wide regulations stipulate that the AC "may complete the syllabus in each one of the specialities with other modules different to the ones provided for in this Royal Decree" (Art. 11.2 of RD318/2000).

On the one hand, it transpired that certain AC were teaching modules that were not proposed in the state-wide regulation: Catalonia was the only autonomous community where "Group didactics and dynamics", "The psychology of mountaineering sports and climbing", "Climbing facilities equipment" and "Technical training and methodology of climbing teaching" were taught (they are not provided for in RD318/2000). It should be noted that Andalusia did not teach "Technical training and methodology of ski mountaineering teaching" and was the only autonomous community that offered "Technical training in mountain progression". Certain modules are given different names in different AC, for example "Safety and risk management" in Aragon (called "Safety in sports" in the state-wide regulation) and "Knowledge of the environment" in Catalonia (this name replaces "The canyon environment").

On the other hand, the HSI qualifications of all the sports are homogeneous: all the AC have the same modules, coinciding with RD318/2000 (except for Order ECI/858/2005, of 28 March, in which a module that is not contained in RD318/2000 is taught in HSI Ski mountaineering and Climbing "Leading in mountaineering and ski mountaineering").

The new teaching courses established by Royal Decrees 701/2019 and 702/2019 have reformulated and changed the structure and the name of the modules to be taught. The modules are grouped into CB and SB. It should be mentioned that there are three same modules for the three MLVT modules in SB, meaning that if someone studies more than one sport they will only have to do these three modules once. The AVT teaching contents share a CB dedicated to high performance and the training of sports trainers. The AVTClimbing SB is comprised of six modules and the AVTHigh of seven, one of which is practical training.

New teaching contents include topics that were formerly studied only in some AC. For example, IVTWalking, "The basics of sports behaviour" now includes contents related to "Group didactics and dynamics", formerly taught in Catalonia alone. In the four MLVT sports, "The basics of sports learning" includes some contents related to "The psychology of mountaineering and climbing sports" and the "Climbing facilities equipment" module, formerly only taught in Catalonia, and these contents are now included in the "Advanced climbing technique" module in MLVTClimbing.

The new state-wide legislation clarifies that the AC "will establish the corresponding syllabuses, observing the provisions" of RD701/2019 (art. 15) and RD702/2019 (art. 28). As yet, it is unknown whether each AC's regulatory development will or will not stick to the module structure provided for by the new regulation.

6. Proportion of theory and practice hours

The previous qualifications (RD318/2000) established a proportion of hours of theory and practice. The regulations developed by the AC established their own distribution of theory and practice hours. Tables 9 and 10 display the percentage of theory and practice hours out of total CB and SB time and the difference between this percentage and the one which is established in the MC. The analysis shows that in the CB and SB of all training levels, most of the AC, had a larger proportion of practical time compared to the proportion established in the MC.

Some AC presented substantial differences in percentage terms compared to the provisions of the MC in RD318/2000 (for example, the highest difference value highlighted in tables 9 and 10). It should be noted that the Balearics AC did not distinguish between theory and practice hours in its regulation of SI2 and TDS (it designed "theoretical-practical" hours), and was therefore not analysed in this section.

Moreover, the new legislation makes provision for a core syllabus which, unlike the previous MC of RD318/2000, makes no distinction between theory and practice.

Table 9

Previous qualifications: Percentage of theory and practice hours out of the total number of hours of CB and SB. Difference with regard to the percentage corresponding to the MC. Level: SI1 and SI2.

% theoretical hours and % practical hours out of the total number of hours and difference between AC and RD318/2000	MC		ARAGON		CATALONIA		AUT. COMMUNITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		BALEARICS		AUT. COMMUNITY OF NAVARRA		ECI858	
SI1 of Mountain and Climbing Sports																						
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	84.6	15.4	80.0	20.0	83.3	16.7	76.9	23.1	66.7	33.3	73.9	26.1	78.3	21.7	71.4	28.6	71.4	28.6	78.3	21.7	71.4	28.6
difference with regard to MC	.0		-4.6	4.6	-1.3	1.3	-7.7	7.7	-17.9	17.9	-10.7	10.7	-6.4	6.4	-13.2	13.2	-13.2	13.2	-6.4	6.4	-13,2	13,2
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	50.0	50.0	33.3	66.7	63.0	37.0	32.1	67.9	30.8	69.2	44.0	56.0	32.3	67.7	53.6	46.4	35.7	64.3	41.9	58.1	25.0	75.0
difference with regard to MC	.0		-16.7	16.7	13.0	-13.0	-17.9	17.9	-19.2	19.2	-6.0	6.0	-17.7	17.7	3.6	-3.6	-14.3	14.3	8.6	-8.6	-25.0	25.0
SI2 High-Mountain																						
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	87.5	12.5	77.3	22.7	93.3	6.7	60.0	40.0	70.4	29.6	75.0	25.0	79.2	20.8	73.7	26.3					73.7	26.3
difference with regard to MC	.0		-10.2	10.2	5.8	-5.8	-27.5	27.5	-17.1	17.1	-12.5	12.5	-8.3	8.3	-13.8	13.8					-13.8	13.8
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	26.7	73.3	16.9	83.1	38.3	61.7	22.7	77.3	26.2	73.8	30.0	70.0	11.2	88.8	25.0	75.0					13.2	86.8
difference with regard to MC	.0		-9.7	9.7	11.7	-11.7	-3.9	3.9	-0.4	0.4	3.3	-3.3	-15.5	15.5	-1.7	1.7					-13.4	13.4
SI2 walk-up																						
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	87.5	12.5	77.3	22.7	93.3	6.7	60.0	40.0	70.4	29.6	75.0	25.0	79.2	20.8	73.7	26.3			62.5	37.5	73.7	26.3
difference with regard to MC	.0		-10.2	10.2	5.8	-5.8	-27.5	27.5	-17.1	17.1	-12.5	12.5	-8.3	8.3	-13.8	13.8			-25.0	25.0	-13.8	13.8
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	33.3	66.7	22.5	77.5	42.9	57.1	41.5	58.5	36.1	63.9	35.6	64.4	15.1	84.9	34.9	65.1			21.1	78.9	16.3	83.7
difference with regard to MC	.0		-10.8	10.8	9.5	-9.5	8.1	-8.1	2.8	-2.8	2.2	-2.2	-18.2	18.2	1.6	-1.6			-12.3	12.3	-17.1	17.1
SI2 Canyoning																						
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	87.5	12.5	77.3	22.7	93.3	6.7	60.0	40.0	70.4	29.6	75.0	25.0	79.2	20.8	73.7	26.3					73.7	26.3
difference with regard to MC	.0		-10.2	10.2	5.8	-5.8	-27.5	27.5	-17.1	17.1	-12.5	12.5	-8.3	8.3	-13.8	13.8					-13.8	13.8
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	38.9	61.1	22.5	77.5	42.9	57.1	36.6	63.4	30.6	69.4	35.6	64.4	16.0	84.0	24.2	75.8					18.6	81.4
difference with regard to MC	.0		-16.4	16.4	4.0	-4.0	-2.3	2.3	-8.3	8.3	-3.3	3.3	-22.9	22.9	-14.7	14.7					-20.3	20.3
SI2 Climbing																						
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	87.5	12.5	77.3	22.7	93.3	6.7	60.0	40.0	70.4	29.6	75.0	25.0	79.2	20.8	73.7	26.3			79.2	20.8	73.7	26.3
difference with regard to MC	.0		-10.2	10.2	5.8	-5.8	-27.5	27.5	-17.1	17.1	-12.5	12.5	-8.3	8.3	-13.8	13.8			-8.3	8.3	-13.8	13.8
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	26.9	73.1	18.2	81.8	40.0	60.0	30.4	69.6	25.5	74.5	35.0	65.0	12.1	87.9	29.3	70.7			21.9	78.1	13.8	86.2
difference with regard to MC	.0		-8.7	8.7	13.1	-13.1	3.4	-3.4	-1.4	1.4	8.1	-8.1	-14.8	14.8	2.4	-2.4			-5.0	5.0	-13.1	13.1

Source: own compilation

Table 10
Previous qualifications: Percentage of theoretical hours and practical hours out of the total number of hours of CB and SB. Difference with regard to the percentage corresponding to the MC. Level: HSI.

% theoretical hours and % practical hours out of the total number of hours and difference between AC and RD318/2000	MC		ARAGON		AUTONOMOUS COMMUNITY OF MADRID		ANDALUSIA		ASTURIAS		BASQUE COUNTRY		CANTABRIA		ECI858	
HSI High-Mountain																
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	72.7	27.3	70.0	30.0	71.0	29.0	72.5	27.5	64.5	35.5	64.3	35.7	64.5	35.5	64.5	35.5
difference with regard to MC	.0		-2.7	2.7	-1.8	1.8	-.2	.2	-8.2	8.2	-8.4	8.4	-8.2	8.2	-8.2	8.2
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	39.1	60.9	29.4	70.6	37.0	63.0	34.8	65.2	32.7	67.3	16.7	83.3	32.7	67.3	22.0	78.0
difference with regard to MC	.0		-9.7	9.7	-2.2	2.2	-4.3	4.3	-6.4	6.4	-22.5	22.5	-6.4	6.4	-17.1	17.1
HSI Climbing																
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	72.7	27.3	70.0	30.0	71.0	29.0	72.5	27.5	64.5	35.5	64.3	35.7	64.5	35.5	64.5	35.5
difference with regard to MC	.0		-2.7	2.7	-1.8	1.8	-.2	.2	-8.2	8.2	-8.4	8.4	-8.2	8.2	-8.2	8.2
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	56.5	43.5	38.1	61.9	41.3	58.7	39.1	60.9	36.4	63.6	35.1	64.9	34.5	65.5	30.0	70.0
difference with regard to MC	.0		-18.4	18.4	-15.2	15.2	-17.4	17.4	-20.2	20.2	-21.4	21.4	-22.0	22.0	-26.5	26.5
HSI Ski mountaineering																
CB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	72.7	27.3	70.0	30.0	71.0	29.0	72.5	27.5	64.5	35.5	64.3	35.7	64.5	35.5	64.5	35.5
difference with regard to MC	.0		-2.7	2.7	-1.8	1.8	-.2	.2	-8.2	8.2	-8.4	8.4	-8.2	8.2	-8.2	8.2
SB	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
% with regard to the total	56.5	43.5	38.1	61.9	41.3	58.7	39.1	60.9	36.4	63.6	35.1	64.9	34.5	65.5	30.0	70.0
difference with regard to MC	.0		-18.4	18.4	-15.2	15.2	-17.4	17.4	-20.2	20.2	-21.4	21.4	-22.0	22.0	-26.5	26.5

Source: own compilation.

Discussion

Previous papers reveal heterogeneity in the legislation governing OSPA in Spain and describe a lack of clarity and consensus (Inglés & Seguí, 2012b), concurring with the results of this article. On the one hand, such heterogeneity may be seen in a positive light as it allows each AC to adapt to their specific needs (Inglés & Seguí, 2012a) and adjust the legislation to the activities performed in each area (Nasarre, 2000). On the other hand, the need for homogenisation emerges in several areas related to OSPA. With regard to qualifications, there is an evident need to promote homogeneity of the different disciplines involved in mountaineering (Nasarre, 2016), which is also endorsed by this paper, since "there is a lack of sufficient awareness to propose regulation by means of a single regulatory instrument for all outdoor sports" (Nasarre, 2016, p. 103). In sports teaching in general, the paper by Madrera et al. (2015) points to the need to review the diverse implementation by the AC. This heterogeneity seems to go beyond Spain and extend to the European Union overall: extensive analysis of vocational training in sports in general was conducted, the conclusion being that there was great diversity in the forms of regulations in place and diversity in sports vocational training and education policies (Projet Vocasport, 2004).

This heterogeneity among regulations also occurs in active tourism (Inglés & Seguí, 2012a) in important areas such as safety, insurance (Mediavilla, 2014), the type of activities regulated and the qualifications required to work as a professional (Bonnet et al., 2018). Generally speaking, the requirements provided for by the different autonomous community regulations do not converge. This means that "national regulation involving minimum contents" because this is a young sector in the process of consolidation (Mediavilla, 2014, p. 85), convergence between regulations (Nasarre, 2008) and the implementation of "legal and economic instruments to standardise" such regulation (Bonnet et al., 2018, p. 53) are all needed. These conclusions are aligned with this study: legislative heterogeneity between AC that runs counter to the state-wide validity of the qualifications. The new legislation that establishes the qualifications partially remedies the aforementioned acknowledged heterogeneity and is an opportunity to establish common lines to consolidate teaching and to ensure that it is tailored to the sector's real needs.

Conclusions

The qualifications that were in force up until 2019 presented an evident heterogeneity between the different AC and the state-wide regulations for SI1 and SI2 in terms of the identification of qualifications, units of competency, professional skills and professional profile. Although there was a majority consensus with regard to location in the sport setting, only some AC provided for and defined the performance of the profession in the areas of free time, leisure and/or active tourism. This generated problems in professional practice and also in boundaries between autonomous communities, mobility between them and also rendering it difficult to draw comparisons with other countries. The current qualifications make provision for names, a structure that defines the professional profile, competencies and professional environment, remedying the gaps and inconsistencies of the previous legislation (provision is now made for via ferratas, clarification is provided in terms of competency in leisure, tourism and free time, as well as with regard to instructors who can be engaged to work as summer walk-up and low-mountain guides, among others). The new regulations have established specialisations, although a structure has yet to be determined. One noteworthy consequence of the equivalences between previous and new qualifications is that differences in competencies between instructors of the same level are created.

In the previous qualifications, some AC added or simply did not teach some of the modules provided for in the state-wide regulation, and some people who trained in different AC have worked professionally although they studied different syllabuses. The new qualifications force the AC to observe the provisions of the state-wide regulations.

Total teaching time and time distribution of modules were heterogeneous across the different AC, meaning that obtaining certain qualifications required more or less time depending on the autonomous community. None of the AC in any training level observed the proportion of theory and practice hours provided for in the MC (RD318/2000). The new regulations also make provision for total course time and a core syllabus that the AC must stick to. No provision is made for separation between theory and practice hours in the new regulation. On the one hand, the AC are free to regulate time distribution. On the other hand, they have no basic guidance for distributing theory and practice and must do so as they see fit, which once again could lead to a situation of widespread heterogeneity.

Mention must also be made of the increased number of hours required to obtain the new qualifications, calling for greater time and financial commitment by students. In turn, problems related to the difficulty in accessing the AVTHigh qualification are heightened since students are obliged to study IVTWalking, MLVTClimbing and MLVTWalk-up with the resulting investment in terms of time and money involved in comparison with the previous qualifications.

With regard to the goal of convergence in professional practise, there is an obvious need for consensus in the main lines (units of competency, professional skills, professional profile, total course duration, modules and time distribution). The new legislation clarifies many of these aspects, although it also raises some questions: Will the AC develop syllabuses for the 2021/22 academic year? Will all the modules provided

for in the state-wide regulations be taught in all the AC? How will hours and the proportion of theory and practice be distributed in the syllabuses ultimately drawn up? When and how will the specialisations be defined; how many teaching hours will be necessary? Will they be compulsory? Will the increased number of teaching hours compared to previous qualifications affect the students' situation? Does the new distribution of competencies, the elimination of two qualifications and the new restructuring truly cater to the needs of instructors, companies and other stakeholders? Moreover, a comparative analysis will need to be performed once the AC have published their own syllabuses.

The comparison of these conclusions with qualitative data that include the appraisal of the situation made by the instructors and entrepreneurs who engage in mountaineering and climbing along with training schools and other stakeholders could be of interest in the future, as might the subsequent application of this analysis to other specialities in technical training in OSPA

Contribution

The contribution made by each author to this research is as follows:

Second author: formulation of the theoretical approach, supervision of the methodological process and review of the final manuscript.

First author: content analysis and drafting of the manuscript.

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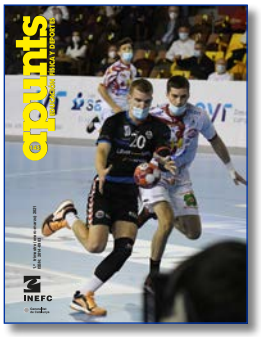
Conflict of Interests: No conflict of interest was reported by the authors.

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.08



OPEN ACCESS

Non-linear Pedagogy in Handball: the Influence of Drill Constraints

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Cite this article:
Flores-Rodríguez, J., & Ramírez-Macías, G. (2021). Non-linear Pedagogy in Handball: the Influence of Drill Constraints . *Apunts. Educación Física y Deportes*, *143*, 73-83. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.08

Editor:

ISSN: 2014-0983

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Section:
Sport Pedagogy

Original language:
Spanish

Received:
6 February 2020

Accepted:
8 July 2020

Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

The manipulation of drill constraints facilitates the performance of certain sports behaviours and according to non-linear pedagogy is the main tool with which coaches can accomplish their proposed objectives. The objective of this paper was to ascertain the influence exercised by certain constraints (no-bounce rule, compulsory passing and receiving while running and making at least five passes to be able to score) in handball players' offensive behaviours. The study participants were the 14 members of a men's U-15 team with ages ranging between 14 and 15 years ($M = 14.6$ years, $SD = 0.4$). Using a specific/nomothetic/multidimensional technique design, 24 matches were studied in a modified game situation in the course of six training sessions to which the constraints studied were applied. Moreover, the use of an individual defensive system was obligatory. An ad hoc observation instrument was designed and was input into the Dartfish 5.5 program, which was used as the recording instrument; intra- and inter-observer concordance and sequential delay analysis was performed using the GSEQ 5.1 program. The HOISAN 1.2 program was used for the polar coordinate analysis, which demonstrated the emergence of different behaviours in order to retain ball possession, progress towards the opponent's goal and finish the attack according to the constraints applied. These findings may indicate the most suitable drill constraints for accomplishing the proposed objectives and avoiding the selection of drills on the basis of subjective criteria.

Keywords: handball, offensive behaviours, polar coordinate analysis, individual defence.

Introduction

Non-linear pedagogy is one of the main precursors of the teaching models based on the complexity sciences (Chow et al., 2007). Using it may deliver better results in the training of certain skills in team sports as opposed to those obtained through the use of methodologies based on behavioural and/or cognitive learning theories (Roberts et al., 2019). For non-linear pedagogy, learning is seen as a process of self-organisation that emerges from the interaction between the player and the drill, since as the player acts they create new behaviour patterns or modify existing ones to meet the constraints present (Balagué et al., 2014).

The role of the constraints introduced into the drills is key since reducing the number of behaviours available enables the sportsperson to perform certain technical and tactical skills to the detriment of others (Renshaw & Chow, 2018). Hence, the action performed is the result of the interaction between the three types of constraints present: environmental (weather conditions, the presence of spectators, etc.), the player's own (skill level, psychological and anthropometric characteristics, etc.) and the drill's (objectives, rules, playing area, etc.) (Chow et al., 2015). The manipulation of drill constraints is viewed as the main tool available to coaches in the teaching of team sports, since manipulating them can provide guidance in the player's self-organisation process in order to accomplish the proposed learning objectives (Renshaw & Chow, 2018).

More empirical knowledge about the influence brought to bear by certain constraints applied to the drill in the learning of individual and group behaviours specific to team sports needs to be generated (Correia et al., 2018). However, there are no papers that address the influence of drill constraints in the teaching-learning process in handball from the standpoint of non-linear pedagogy.

In this respect, the use of observational methodology has been shown to be particularly appropriate since it makes it possible to study sports actions in the context in which they take place (Anguera & Hernández-Mendo, 2013). In handball, several papers have applied this methodology for the analysis of elite competition (Flores & Anguera, 2018; González et al., 2013; Lozano et al., 2016; Lozano & Camerino, 2012; Montoya et al., 2013; Sousa et al., 2015; Trejo & Planas, 2018), although it is seldom used in the study of training stages. In fact, training stages in handball have been investigated from other methodological standpoints. Hence, the papers by Antúnez et al. (2013) and García et al. (2008) focused on the performance indicators of teams that won the Spanish Championships in the U-13 and U-15 categories. Meanwhile, Antón (1998) and Feu (2006) made proposals for the organisation and development of the teaching-learning process based on relating teaching objectives and contents to the principles of the game.

For all these reasons and due to the need for greater empirical knowledge about the influence of drill constraints in the teaching-learning process in handball, this paper set out to ascertain the influence exercised by certain drill constraints (no-bounce rule, mandatory passing and receiving the ball while running and the obligation to make at least five passes to be able to score) on the behaviour of handball players during the attack phase. Obtaining evidence in this respect could help to optimise training programmes by preventing coaches from manipulating drill constraints subjectively (Renshaw & Chow, 2018).

Methodology

This research is based on a specific/nomothetic/multidimensional (S/N/M) (Anguera et al., 2011) design: specific in analysing the records of the different sessions overall; with inter-session monitoring, since behaviour in the course of the sessions is recorded; nomothetic in that the players were assigned to two teams and the behaviours of several units are studied (blue team and orange team), and finally, multidimensional in that different response levels were studied.

Participants

The study involved the 14 players of a handball team, all the team members, competing in a men's U-15 provincial league in the region of Andalusia. The participants had a mean age of 14.6 years (SD = 0.4), and in the course of the research they played various matches in a modified game situation to which the constraints being studied were applied. The research was performed in accordance with the ethical standards applicable to observational methodology established in the Declaration of Helsinki and with the consent of the Research Ethics Committee of the Virgen Macarena-Virgen del Rocío University Hospitals with code 0723-N-20. The parents also gave their consent for their children to participate in this study.

Instruments

Observation instrument

An ad hoc observation instrument (Table 1) was constructed to record the most relevant behaviours with respect to the proposed objective. Due to the lack of theoretical constructs

and the multidimensional nature of the behaviours to be studied, a design combining the field format with mutually exclusive and collectively exhaustive categories systems was chosen. This combination leverages the strong points of both components since the categories system provides theoretical consistency, while the field format affords flexibility in recording the specific behaviours to be studied (Anguera & Hernández-Mendo, 2013).

The purpose was to build an instrument that would make it possible to record the most relevant behaviours in the accomplishment of the three objectives of the attacking phase: maintaining possession of the ball, progressing

Table 1
Observation instrument.

Criterion	Category and code	Description
Constraint (CON)	Bounce (NBR)	The game is played with a no-bounce rule.
	Movement (MVT)	There is also the obligation to receive and pass in movement.
	Five passes (PS5)	The game is played with the obligation to make at least five passes before taking a shot on goal
Team (TEA)	Orange (ORA)	The orange team attacks
	Blue (BLU)	The blue team attacks
Beginning (INI)	Goalkeeper (GOA)	The attack begins with a goal throw
	Recovery (RCU)	The attack begins after the ball is recovered
	Free throw/throw-in (FTT)	The attack begins after a throw-in or free throw
Number of players (NPL)	One (ONE)	One player has possession of the ball during the attack
	Two (TWO)	Two players have possession of the ball during the attack
	Three (THR)	Three players have possession of the ball during the attack
	Four (FOU)	Four players have possession of the ball during the attack
Number of passes (NPA)	From zero to two (P02)	Between zero and two passes are made during the attack
	From three to five (P35)	Between three and five passes are made during the attack
	From six to eight (P68)	Between six and eight passes are made during the attack
	Nine or more (P99)	Nine or more passes are made during the attack
Moving the ball (MTB)	Long pass (LPA)	The opponent's half is reached after a long pass
	Short pass (SPA)	The opponent's half is reached after a short pass
	Movement with ball (BSE)	The opponent's half is reached after a player executes a movement with the ball
	Opponent's half (AOH)	The attack begins when the team is already in the opponent's half
	Own half (NOT)	The attack does not reach the opponent's half ***
Collective behaviours (TAC)	Pass and move (PAM)	The first tactical resource used by players is pass and move
	Cross (CRO)	The first tactical resource used by players is the cross
	Exchange (EXC)	The first tactical resource used by players is the exchange
	Block (BLO)	The first tactical resource used by players is the block
	Force switch of defender (FSD)	The first tactical resource used by players is to force a switch of defender
	Free play (NTR)	Free play, using no tactical resource

Table 1 *(Continuation)*
Observation instrument.

Criterion	Category and code	Description
Finishing (FIN)	Shot (SHO)	The attack ends after a shot
	Loss (LOS)	The attack ends after a ball loss
	Interruption (INT)	The attack ends with an interruption, without the team losing possession of the ball: free throw, throw-in or referee intervention.
Finishing zone (ZON)	Left (LZO)	The attack ends in the left sector of the opponent's half
	Right (RZO)	The attack ends in the right sector of the opponent's half
	Centre (CZO)	The attack ends in the central area of the opponent's half
	Own half (OWH)	The attack ends in the team's own half
Finishing action (FAC)	Feint (FET)	The player finishing the attack executes a feint just before taking a shot, losing the ball or there is an interruption
Finishing action (FAC)	Lose marker (LOM)	The player finishing the attack loses their marker just before taking a shot, losing the ball or there is an interruption
	Movement with ball (MOB)	The player finishing the attack executes a movement with the ball just before taking a shot, losing the ball or there is an interruption
	Pass or reception (POR)	The player finishing the attack makes a passing reception error just before taking a shot, losing the ball or there is an interruption
	Solo attacker (SOL)	The player finishing the attack takes a shot on goal after receiving the ball without the presence of a defender.

towards the opponent's goal and finishing (Antón, 1998; Feu, 2006). The instrument was constructed in three phases. 1) Two national handball coaches, one with experience in observational methodology and the other the coach of the team being studied, constructed an initial version from the theoretical review performed in which the work by Feu (2006) and Lozano et al. (2016) was particularly useful. 2) Subsequently, three matches not included in the sample with similar characteristics to those involved in the study were recorded. As no new behaviours in any criterion were detected, the level of caution was deemed achieved. 3) The instrument was submitted to the judgement of five experts, university handball teachers and national coaches. Following the reading and explanation of the observation instrument, the experts completed an assessment template in which they were asked to state whether or not they agreed with each criterion and category. Five experts were polled, and agreement with all the criteria and categories defined in the observation instrument surpassed 79% in all cases.

The observation instrument was ultimately comprised of 10 criteria and 40 categories. The observation units were

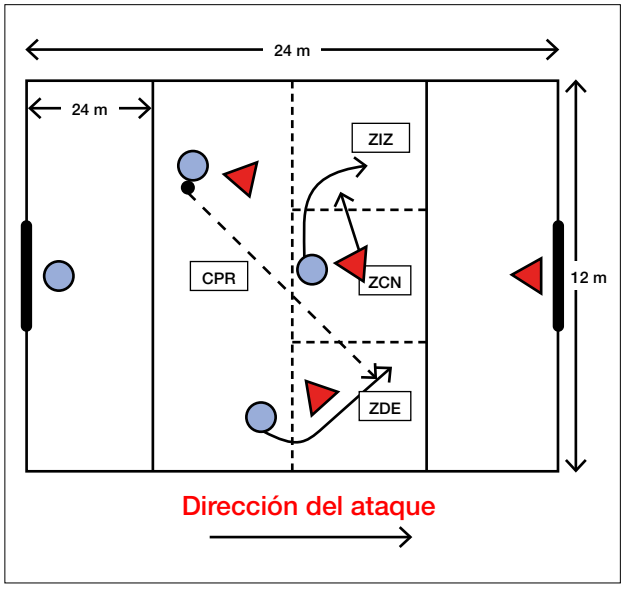


Figure 1
Modified game situation match to which the constraints studied were applied.
Note. OWH: own half; LZO: opponent's half left side; CZO opponent's half centre; RZO: opponent's half right side

the attacks executed in the matches. It began when one team took possession of the ball and ended when a shot was made, the ball was lost or the referee stopped play.

Recording instruments

The observation instrument was input into the Dartfish 5.5 program to record and code the actions. Prior to this, each of the sessions was recorded with a Sony FDR-AX33 camera located at a height of 4 metres behind one of the goals.

Intra- and inter-observer concordance was calculated with the GSEQ program version 5.1 (Bakeman & Quera, 2011). In order to ascertain the behaviours of the players in the presence of the different constraints analysed, the polar coordinate analysis was applied using the HOISAN 1.2 program (Hernández-Mendo et al., 2012). Prior to the calculation of the polar coordinates, and as a prerequisite, the sequential delay analysis was performed, considering delays of +1 to +5 for the prospective perspective and -1 to -5 for the retrospective perspective, using the GSEQ 5.1 program. For this purpose, the records of both teams were merged into the same pool. Finally, the significant associations obtained with HOISAN 1.2 were represented graphically with the Snowflake 0.2 program.

Procedure

The study was performed in the course of six sessions conducted in the team's regular training facility and timetable. All the sessions presented the same structure: a warm-up (10 minutes), followed by a main part (40 minutes) and finally a cool-down drill (10 minutes). The main part of the training involved matches played in a modified game situation (Fig. 1). Each match lasted eight minutes with a two-and-a half minute rest between matches, making a total of four matches per session and 24 matches in the research overall.

With regard to match organisation, the players were divided randomly into two teams that did not change in the course of the study. It ought to be emphasised that the teams were obliged to use an individual defensive system in all matches. It should also be mentioned that, according to Chow et al. (2015), modified game situations, in that they conserve the structure and essence of real-life sport, allow players to develop the individual and interaction behaviours specific to the sport being taught, in this case handball.

The course of the matches was conditioned by the presence of the three constraints being studied: 1) no-bounce rule (NBR), applied in the matches played in sessions one and four; 2) obligation to pass and receive in movement (MVT), applied in the matches pertaining to sessions two and five, and 3) the obligation to make at least five passes before scoring (PS5), applied in the matches pertaining to sessions three and six.

Finally, it should be stressed that the coach did not issue any type of instructions related to behaviour before, during or after the matches.

Observational analysis

Data quality

The actions were recorded and coded by two observers (national handball coaches). Both of them participated in a training process to optimise observation reliability. The training comprised two phases: the first, particularly for one of the observers who did not participate in the production of the observation instrument, in which the criteria and categories of the observation instrument were explained and studied in theoretical terms; and the second, more practical phase, in which the different matches that were not included in the sample were recorded. The training process concluded when concordance levels above 0.80 were obtained in Cohen's Kappa statistical test for all the criteria both at intra-observer level, the same session recorded by the same observer at two different times (after 16 days), and also at the inter-observer level, the same session recorded by the two observers.

Once the training phase had ended, the behaviours obtained in each of the six study sessions were recorded and coded. The intra-observer and inter-observer concordance levels were calculated, yielding in both cases a Cohen's Kappa coefficient above 0.95 in all the criteria. In accordance with Landis and Koch (1977, page 165) the level of agreement displayed in both tests may be regarded as "almost perfect".

Polar coordinate analysis

Polar coordinate analysis makes it possible to ascertain the behaviour patterns that emerge during the performance of sports and is used in an increasing number of research papers (Castañer et al., 2016, Castañer et al., 2017; López-López et al. 2015; Sousa et al., 2015). This analysis permits the vectorial representation of associations, whether activation or inhibition, between the behaviours being studied.

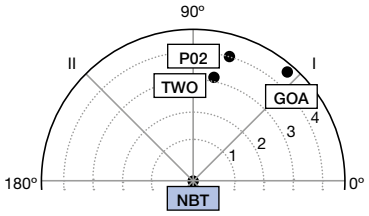
As a prerequisite for their calculation, the sequential analysis of perspective and retrospective delays has to be performed (Sackett, 1980). For this purpose, the same number of delays in both perspectives is considered, using positive delays of 1 to 5 for prospective and negative delays of -1 to -5 for retrospective. In the prospective perspective, a type of behaviour called focal behaviour is proposed, regarded as

"forward-generating" a series of relationships with the other categories, which are seen as conditioned behaviours. The retrospective perspective seeks to ascertain to what extent there are significant "backward" relationships between focal and conditioned behaviours.

Using the prospective and retrospective sequential analyses, the polar coordinate analysis integrates both of them by applying the $Z_{sum} = \frac{\sum Z}{\sqrt{n}}$ (Sackett, 1980) statistic, a powerful data reduction technique. Each prospective and retrospective "Zsum" may be positive or negative, meaning that the combination of the signs will determine in which one of the four possible quadrants (I, II, III, IV) the associations obtained between focal and conditioned behaviours will be located. Quadrant I indicates a relationship of mutual activation between focal and conditioned behaviour; quadrant IV indicates that the focal behaviour activates the conditioned behaviour, while it is inhibited by it; quadrant III points to a relationship of mutual inhibition between both behaviours, and finally, quadrant II means that focal behaviour inhibits conditioned behaviour, whereas conditioned behaviour activates focal behaviour (Anguera et al., 2011).

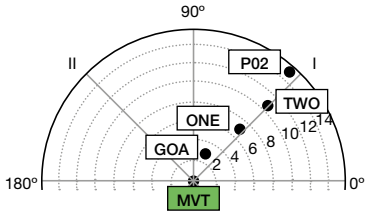
Results

Following the application of the polar coordinate technique, the significant associations, i.e. those with a length >1.96 ($p < 0.05$), between focal behaviour and the conditions were graphically represented in figures 2, 3 and 4. The constraints entered into the course of the matches acted as focal behaviours since it was necessary to ascertain the influence exercised by each constraint in order to meet the objective of this research. The other categories of the observation instrument acted as conditioned behaviours and were distributed as follows: in Figure 2, those pertaining to the criteria related to the principle of retaining the ball (beginning, number of players and number of passes). Figure 3 shows the categories of the criteria related to the principle of progressing towards the rival goal (movement of the ball and collective skills). Finally, in Figure 4 the categories of the criteria related to the principle of finishing the attack were used as conditioned behaviours (finishing area, finishing action and finishing). The relationships located in quadrant 1 will be studied to facilitate comprehension of the results. Figure 2 shows how the no-bounce rule (NBR) presented a relationship of activation with attacks begun with a goal throw



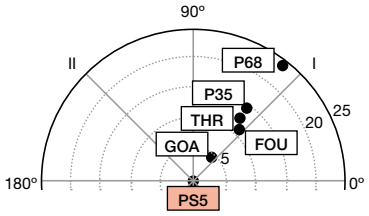
Focal category: no-bounce rule (NBR)

Cat.	Quadrant	Radius	Angle
TWO	I	3.16	75.19
P02	I	3.98	70.23
GOA	I	4.47	48.71



Focal behaviour: passing and receiving in movement (MVT)

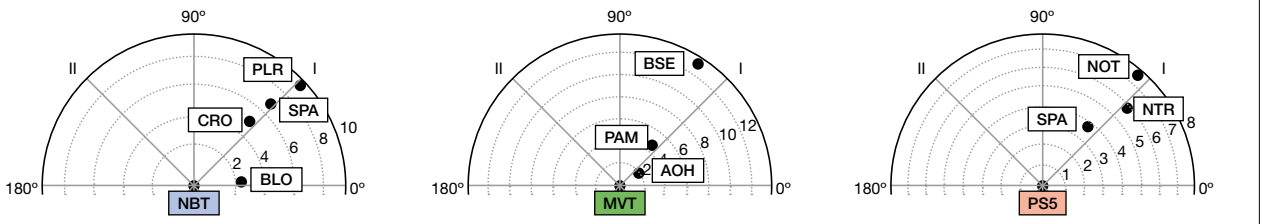
Cat.	Quadrant	Radius	Angle
GOA	I	2.71	65.71
ONE	I	6.91	48.14
TWO	I	10.77	44.60
P02	I	15.00	48.50



Focal behaviour: complete at least five passes to score (PS5)

Cat.	Quadrant	Radius	Angle
GOA	I	4.47	48.71
FOU	I	11.07	47.02
THR	I	12.45	52.02
P35	I	14.35	51.93
P68	I	23.86	51.44

Figure 2
Relationships of activation between focal behaviour and criteria related to the principle of retaining the ball.
Note. Cat.: category; TWO: Two players are involved; P02: zero to five passes are made; GOA: the attack begins with a goal throw; ONE: one player is involved; FOU: four players are involved; THR: three players are involved; P35: three to five passes are made; P68: six to eight passes are made



Focal category: no-bounce rule (NBO)

Cat.	Quadrant	Radius	Angle
BLO	I	2.38	8.59
CRO	I	5.22	50.26
SPA	I	6.73	47.09
PLL	I	9.64	43.97

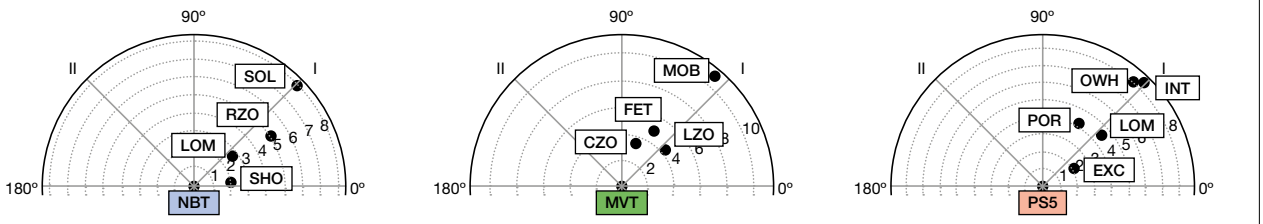
Focal behaviour: passing and receiving in movement (MVT)

Cat.	Quadrant	Radius	Angle
AOH	I	2.03	31.46
PAM	I	4.62	50.30
BSE	I	13.13	56.82

Focal behaviour: complete at least five passes to score (PS5)

Cat.	Quadrant	Radius	Angle
SPA	I	3.77	51.02
NTR	I	5.93	40.53
NOT	I	7.74	47.91

Figure 3
Relationships of activation between focal behaviour and criteria related to the principle of progressing with the ball
Note. Cat.: category; BLO: block; CRO: cross; SPA: short pass; LPA: long pass; AOH: the attack begins in the opponent's half; PAM: pass and move; BSE: movement with ball; NTR: free play; NOT: do not cross into the opponent's half



Focal category: no-bounce rule (NBR)

Cat.	Quadrant	Radius	Angle
SHO	I	2.09	8.59
LOM	I	2.68	50.26
RZO	I	5.13	47.09
SOL	I	8.02	43.97

Focal behaviour: passing and receiving in movement (MVT)

Cat.	Quadrant	Radius	Angle
CZO	I	3.47	73.38
LZO	I	4.30	40.84
FET	I	4.84	60.90
MOB	I	10.97	50.19

Focal behaviour: complete at least five passes to score (PS5)

Cat.	Quadrant	Radius	Angle
EXC	I	2.05	27.54
LOM	I	4.16	59.48
POR	I	4.55	40.05
OWH	I	8.06	48.06
INT	I	8.38	45.30

Figure 4
Relationships of activation between focal behaviour and criteria related to the principle of finishing
Note. Cat.: category; SHO: the attack ends in a shot; LOM: lose marker; RZO: right area; SOL: solo shot; CZO: central area; LZO: left area; FET: feint; MOB: movement with ball; LOS: the attack ends with loss of possession; OWH: the attack ends in the opponent's half; INT: the attack is interrupted; POR: the attack ends with a pass or receiving error

(GOA), with attacks in which two players had possession of the ball (TWO) and with attacks which were completed with zero to two passes (P02). The same behaviours, albeit with a different radius and angle, were activated in the matches in which it was obligatory to receive and pass while running (MVT); similarly, this constraint presented a relationship of activation with attacks in which one player had possession of the ball (ONE). The obligation to make at least five passes before scoring (PS5) had a very different effect, since it presented a relationship of activation with

attacks involving possession of the ball by three players (THR), with attacks involving possession of the ball by four players (FOU), with attacks completed in three to five passes (P35) and finally with attacks involving between six and eight passes (P68).

Figure 3 shows the categories related to the principle of progressing towards the opponent's goal. The matches played with the no-bounce rule (NBR) presented a relationship of activation with the use of long passes (LPA) and short passes (SPA) to progress towards the opponent's goal, as well as with attacks in which the first tactical resource used by the players was the cross (CRO) and the block (BLO). On the other hand, the obligation of passing and receiving in movement (MVT) gave rise to the activation of attacks which began in the opponent's half (AOH), of attacks involving progression towards the opponent's half by means of movements with the ball (BSE) and of attacks in which the first tactical resource implemented was pass and move (PAM). Moreover, the obligation of completing at least five passes before scoring (PS5) presented a relationship of activation with attacks involving progression by means of short passes (SPA), attacks that did not reach the opponent's half (NOT) and with attacks in which the players did not use any tactical resource (NTR).

Figure 4 shows how the no-bounce rule (NBR) presented an association of activation with attacks that ended in the right side of the opponent's half (RZO), with attacks that ended in a shot (SHO), with a player losing their marker before finishing the attack (LOM) and with a shot after receiving the ball alone without the presence of a defender (SOL). Moreover, the obligation of passing and receiving in movement (MVT) presented activation in attacks completed after a feint (FET) and after a movement with the ball (MOB). With regard to the finishing area, the activation of two areas was observed, central (CZO) and left (LZO). Finally, the obligation of making at least five passes before scoring (PS5) presented activation with attacks that ended in the own half (OWH), with attacks that ended after an interruption (INT), attacks that ended with loss of possession after a passing and/or receiving error (LOS) and with attacks that ended after the player lost their marker (LOM).

Discussion

EThe objective of this study was to ascertain the influence exercised by certain constraints entered into the course of matches in a modified game situation on the attacking behaviours performed by handball players. Following the proposals of Feu (2006) and Antón (1998), the behaviours studied have been linked to the principles of play with different behaviour patterns being found for keeping possession of the ball, progressing towards the rival's goal and finishing attacks depending on the constraint introduced into each of the matches.

With regard to the principle of keeping possession of the ball, research that studied the dynamics of play in handball training stages (Antúnez et al., 2013; García et al., 2008) found that the winning and best-placed teams in the National U-13 and U-15 Championships lost fewer balls. Moreover, the importance of this principle is also underlined in elite competition since lost ball possession can generate counter-attacks, the most effective and one of the most commonly-used tactics by winning teams (González et al., 2013; Lozano & Camerino, 2012). The results obtained in this research show that the obligation of making at least five passes in order to be able to score (PS5), while being the constraint that prompted the performance of a greater number of passes and the involvement of a greater number of players, activated the appearance of ball losses. Apparently, this constraint allowed the rival team to direct their behaviour towards the recovery of possession, obtaining a certain degree of success in this respect. On the other hand, the obligation of passing and receiving in movement (MVT) was the constraint that prompted the performance of fewer passes and the involvement of fewer players in attack. One explanation in this regard may be related to attacking players' perception and action difficulties (the player with the ball could not stop to weigh up the opportunities available to them), which promoted a more individual and direct play dynamic.

With respect to the behaviours performed to progress towards the opponent's goal, Sousa et al. (2015) indicated that one of the main functions of tactical resources is to create opportunities to finish attacks. More specifically, tactical resources involving two or three players are the ones most commonly used against open defences (Lozano et al., 2016). Here it is important to specify the most appropriate tactical resources depending on the context of play. Thus the results obtained show that the no-bounce rule (NBR) was conducive to the performance of blocks and crosses as well as to the performance of short and long passes in order to progress towards the opponent's half. These results appear to indicate that this constraint offers good opportunities for performing off-the-ball actions.

Moreover, the obligation to pass and receive in movement (MVT) was conducive to pass and move as well as to progression towards the opponent's half through moving with the ball. Therefore, in line with what was observed in behaviours intended to maintain ball possession, this constraint generated situations in

which actions involving ball possession predominate. However, the obligation to make at least five passes before scoring (PS5) did not facilitate the implementation of any basic tactical resource, perhaps because this constraint prioritised behaviours seeking to retain the ball with respect to those performed with a view to progressing towards the opponent's half and creating opportunities to finish the attack.

In terms of the finishing of attacks, Montoya et al. (2013) found in elite sport that the finishing percentages of wingers were greater in winning and best-placed teams. Moreover, Antúnez et al. (2013) and García et al. (2008) demonstrated that the winning teams in training categories took more shots from a distance of six metres. This information is very relevant, yet as pointed out by Lozano et al. (2016) it would be a good idea to study the dynamics of play that permit different types of finishes. In this respect, this study found that the no-bounce rule (NBR) is conducive to taking shots after off-the-ball actions such as losing one's marker and receiving the ball without being marked. These results seem reasonable since this constraint places important limitations on movements with the ball, meaning that off-the-ball actions become one of the main finishing tools. On the other hand, the obligation of receiving and passing in movement (MVT) generated a very different dynamic since it activated the use of on-the-ball actions such as feints. The requirement of receiving the ball while running appears to facilitate individual actions geared towards overcoming the defender, which is perhaps due to the advantage enjoyed by the attacker in receiving a ball while moving fast. Moreover, the obligation to make at least five passes before shooting was conducive to attacks ending in passing and/or reception errors.

Finally, the paper emphasises that the results obtained are consistent with one of the core ideas of non-linear pedagogy since the manipulation of drill constraints can guide player behaviour (Chow et al., 2007). Consequently, the challenge to coaches consists of selecting the right constraints that help to accomplish the proposed learning objectives (Correia et al., 2018). For this purpose, and following Feu (2006), when designing training drills coaches must contend with the difficult challenge of foreseeing their players' behaviour. The findings obtained in this paper may partially contribute to optimising this process.

Conclusions

The most important conclusions obtained with regard to the study objective are:

a) The no-bounce rule was conducive to the performance of off-the-ball actions, more specifically: the use of short and long passes to progress, crosses and blocking as basic tactical resources and finishing by means of losing one's marker and marking errors.

b) The obligation of passing and receiving in movement activated the performance of actions with the ball: attacks were executed with fewer passes and the involvement of fewer players than in the presence of other constraints, there was progression towards the opponent's half through possession, the use of pass and move and finishes after a feint.

c) The obligation of performing at least five passes before scoring a goal: this facilitated lost balls and passing and/or receiving errors and also hampered progression towards the opponent's goal and the implementation of basic tactical resources.

One of this study's main limitations is that the influence of individual characteristics was not taken into account when explaining the behaviours performed. For future research it would be advisable to verify the influence of the constraints studied on other players (different age, category, gender, etc.) as well as to analyse matches in which both teams use zone defence systems. Similarly, it would be worthwhile to study progressively the influence of these and other constraints on the behaviours in other game phases.

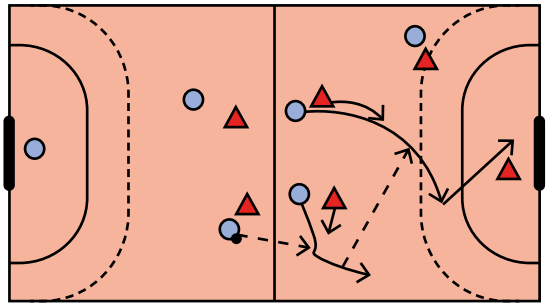
Moreover, the polar coordinate analysis technique, known to be a powerful tool to study elite handball, can also provide very valuable information about the training process in training stages since it reports on the type of self-organisation generated by the training drills proposed. This information could add to any obtained through the use of other tools applied to control training load.

Practical applications

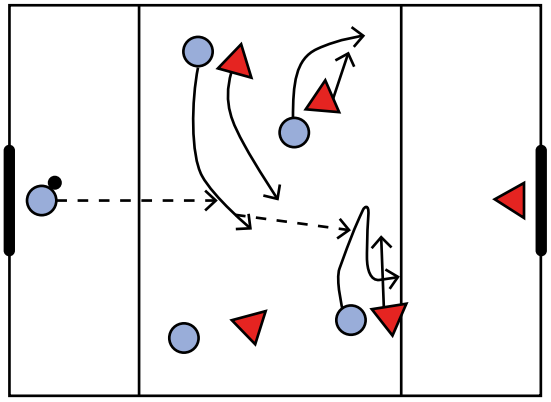
The results obtained may contribute partially to optimising the design of training drills in handball, providing information that will help to select the most suitable drill constraints for the accomplishment of the objectives proposed and thereby avoiding subjective manipulation.

By way of example, three tasks in which the conclusions obtained are applied are presented below:

Description: two teams consisting of five players plus a goalkeeper play a match.
Constraint applied to the task: no-bounce rule.
Play principles mainly requested: progress towards the opponent's goal and retain the ball.
Target behaviours: passes and losing your marker.



Description: two teams consisting of four players plus a goalkeeper play a small-sided game.
Constraint applied to the task: obligation of passing and receiving in movement.
Play principle mainly requested: finish the attack.
Target behaviours: feints and pass and move.



Description: two teams consisting of six players in the middle of the court, one attacks, the other defends and there is a neutral goalkeeper.
Constraint applied to the task: no-bounce rule.
Play principles mainly requested: finish the attack and progress towards the opponent's goal.
Target behaviours: crosses, passes and losing your marker.

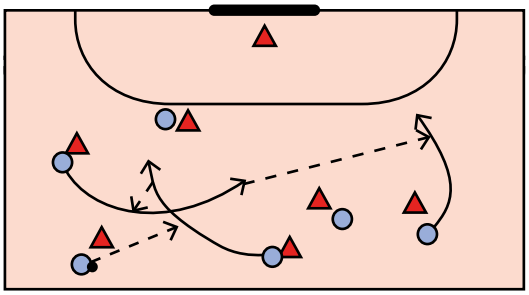


Figure 6
Constraints applied to three tasks and target behaviours.

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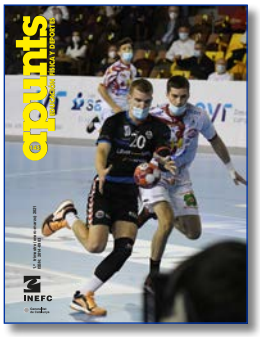
Conflict of Interests: No conflict of interest was reported by the authors.

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.09



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Metabolic Comparison During Protocol of Battling Rope Exercise Using Different Implementation Strategies

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Cite this article:
Rodrigues-Barbosa, R., Perrier-Melo, R,J., Brito-Gomes, J.L.,Freitas-Brito A. & Cunha-Costa, M. (2021). Metabolic Comparison During Protocol of Battling Rope Exercise Using Different Implementation Strategies. *Apunts. Educación Física y Deportes*, *143*, 84-89. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.09

Editor:

ISSN: 2014-0983

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Section:
Physical Preparation

Original language:
English

Received:
16 January 2020

Accepted:
17 July 2020

Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/lafototeca.com

Abstract

Introduction: High-intensity interval exercise is a training method that has been popular according to the American College of Sports Medicine. Traditionally, we verified the predominant usage of ergometers (treadmills and cycle ergometer) during interval exercise sessions. However, battle ropes exercise are a alternative to other exercise modalities. *Purpose*: The aim of the study was to compare heart rate (HR) peak and oxygen consumption (VO_2) peak during a sprint interval exercise (SIE) with a battling rope (BRP), using different execution strategies (simultaneous and alternate oscillations). Materials and Methods: Eight college men (24.9 ± 7.0 years, 25.2 ± 3.6 kg/m^2, and 38.9 ± 3.4 ml·kg^{-1}.min^{-1}) having no experience with battling rope exercises completed two different experimental sessions: simultaneous and alternating arms in a random order, and a 4 × 30 s all out (4 min of passive recovery). We used two-way analysis of variance with a significance of $p < .05$ for the analysis between groups. *Results*: The average oxygen consumption peak (VO_2 peak), obtained during the four bouts of alternating and simultaneous arms was 76.52 ± 12.71 % and 79.58 ± 15.58 %, respectively. The average HR peak reached during the four high-intensity bouts was 85.15 ± 7.10 % and 88.29 ± 5.14%, respectively. *Conclusion*: These data show that there is no difference in the acute cardiovascular response of battling rope protocol exercise involving different modes (alternate or simultaneous). These results suggest that the intensity generated during BRP exercise can be sufficient to improve and maintain maximal oxygen uptake in healthy people.

Keywords: physical exercises, performance, high-intensity interval training.

Introduction

High-intensity interval exercise is a training method that has been popular throughout the scientific community and is classified as one of the top fitness trends according to the American College of Sports Medicine (ACSM) (Thompson, 2020; Veiga et al., 2017). The intensity level of the stimulus in high-intensity conditions characterizes the method of training (Buchheit et al., 2013). When the stimulus is applied between 30 s and 4 min duration, in submaximal (>80%) or maximal (100%) intensity, it is referred to as a high-intensity interval exercise session (HIIE). Alternatively, when the said stimulus is given between 10 and 30 s, in supramaximal intensity (>100% or all out), it is called sprint interval exercise (SIE) (Buchheit et al., 2013). Studies have shown that HIIE and SIE protocols are effective for significantly improving physical fitness related to health and athletic performance (Alonso-Férnandez et al., 2017; Bishop et al., 2007; Buckley et al., 2015; Mcrae et al., 2012; Thompson, 2017).

Traditionally, we verified the predominant usage of ergometers (treadmills and cycle ergometer) during HIIE and SIE sessions. However, research has established that at least eight different devices or sporting modalities can be used. These approaches include different ergometers (rowing, elliptical) (Buckley et al., 2015; Fex et al., 2015), calisthenic exercises (burpee, squatting, jumping, jumping jacks) (Blackwell et al., 2017; Mcrae et al., 2012), sporting modalities (swimming) (Bishop et al., 2007), and implements (boxing bag, battling rope). Among these, the latter has gained scientific popularity, given its considerable advantage in practicality, low impact on joints, and low cost compared to traditional models (Brewer et al., 2018; Chen et al., 2018).

Previous investigations have analyzed the cardiometabolic response during a session of SIE with battling rope in different postures (sitting, standing, jumping) (Brewer et al., 2018) and execution strategies of movement (both simultaneous and alternate oscillations) (Ratamess et al., 2015a, 2015b). Overall, the results show that the metabolic response reached during the battling rope protocol (BRP) is similar to, or greater than, that of many traditional exercises (Ratamess et al., 2015). Nonetheless, up to the present moment, the studies that analyzed metabolic response during a BRP investigated the execution of one movement (e.g., simultaneous) or the sum of movements (simultaneous plus alternate). Therefore, we do not know if there are differences in the metabolic response during one session with different execution strategies (simultaneous vs. alternate) using battling rope exercise. Thus, the aim of the study was to compare the HR peak and VO_2 peak during an SIE with a battling rope, using different execution strategies (simultaneous vs. alternate oscillations).

Methodology

Participants

The *posteriori* sample size calculation was performed using V02 peak ANOVA-values and was based on power (1–β) .9 and an alpha error of.05. Power analyses were computed by the G*Power 3.1.9.21 (Franz Faul, Universität Kiel, Germany) for four repeated measures (correlation among the measures; r=.45), and a minimum of 8 participants were necessary to carry out the study. Eight healthy, habitually active men (24.9±7 years, 38.9±3.4 mL/kg/min) participated in this study (Table 1). Participants were recruited from the university campus, via personal or printed invitations in a university setting, and online social networks. Participants were healthy, exercised regularly before initiating the study, and none were taking any medications or supplements known to affect performance. There were no recent cases (within 12 months) of osteomyoarticular injuries, and all had negative answers to the Physical Activity Readiness Questionnaire.

We dismissed participants who were unable to complete any one of the sessions, or who started another exercise intervention. All participants were informed of the experimental procedures and signed the informed consent. The study was approved by the research ethics committee with human beings (55357016.1.0000.5192; nº033418/2016) of the local university and followed all the norms of resolution 466/12 of the Health National Board.

Procedures

We randomly selected volunteers for exercise sessions that included simultaneous arms (simultaneous) and alternating arms (alternate), in an SIE protocol with 4 × 30 s all out: 4 min of passive recovery, with 48- and 72-hour intervals between sessions. Random numbers taken from the website *www.randomizer.org* defined session randomization. Before the BRP, the volunteers rested for 5 min to analyze their resting heart rate (Polar, FT4 model, Finland) and blood pressure (OMRON DALIAN®, HEM 7113 model, China) to obtain base values at the onset of the activities. We measured the variables HR and VO_2 during the sprints (30 s) and during every minute of recovery (4 min) in all conditions.

Measurements

Initially, we measured the volunteers' body masses and height for the computation of body mass index, using a scale (Filizola, Brazil, 100g precision) and a stadiometer, following the recommendations of the *International Society for the Advancement of Kinantropometry*. To determine

the oxygen peak consumption (VO_2 peak), we used the Buckley protocol (Buckley et al., 2015) with a treadmill (Super ATL, Inbrasport, USA) and a Cortex metabolic computerized analyzer (QUARK COSMED CPET, Italy) in the mode breath by breath and Hans Rudolph Linc masks (USA). Thus, participants underwent one 2-min session of familiarization, focused on performing the exercise in BRP (both simultaneous and alternate). Following familiarization, they were asked to return to the lab between 48 and 72 hours later for the sessions.

Battling rope protocol

The volunteers completed two experimental sessions (25 min each), separated between 48 and 72 hours. Before the BRP, the participants rested for 5 min for the analysis of resting heart rate - HR and blood pressure to obtain safe values to start the efforts. Following this, they had a standard 5-min warm-up and BRP. During the BRP (simultaneous and alternate), the volunteers were instructed to perform the most repetitions in 30 s (receiving verbal conventional encouragement "go, go"), followed by a 4-min passive recovery. The stimulus: recovery (1:8) was repeated four times, totaling 18 min [4x (30 s all out, 4 min recovery)]. In the simultaneous arms session, the participants performed the repetitions simultaneously, while in the alternating arms, they alternated. The rope used was nylon, with a 9.7 m length, 11.4 kg weight, and a circumference of 17 cm, and was fastened to a rod in the ground. The volunteers held approximately 4.85 m of rope in each hand.

Statistical Analysis

Initially, we tested the normality and homogeneity *(Shapiro–Wilk and Levene)*. Two-way analysis of variance (ANOVA) with repeated measures was used to measure differences in VO_2 peak and HR peak between both exercise conditions (simultaneous and alternate arms). Tukey's post hoc analysis was used to determine significant differences. The effect size was calculated with the Psychometrica calculator. The values considered were: $\eta^2 < .20$ trivial, 0.20 – 0.59 small, 0.60 – 1.19 moderate, 1.20 – 1.99 large, and > 2.0 very large effect. The significance level was set at $p < .05$.

Results

All participants completed the stages of the study and were included in the analysis. On average, they were eutrophic, with VO_2 peak values comparable to actively trained men. Individual values are shown in Table 1 and did not identify differences in either of the variables between the participants ($p < .05$).

Figure 1 shows the response of VO_2 peak during the four sprint interval bouts. The VO_2 peak averages during each bout were 29.77 ± 5.15 vs 34.77 ± 7.46 ($p = .56$) in bout 1; 30.27 ± 4.99 vs 31.82 ± 7.17 ($p = .99$) in bout 2; 30.68 ± 7.43 vs 27.62 ± 5.95 ($p = .99$) in bout 3 and 28.23 ± 3.65 vs 29.61 ± 6.92 ($p = .99$) $ml.kg^{-1}.min^{-1}$ in bout 4, during alternating and simultaneous conditions, respectively. The session average (relative) was 76.52 ± 12.71% (alternating arms) and 79.58 ± 15.58% (simultaneous arms). The ANOVA repeated measurements showed that there was no significant

Table 1
Characteristics of the participants of the study (n = 8).

Variable	(mean ± SD)	
Age (years)	24.9 ± 7.0	
BMI (kg/m2)	25.2 ± 3.6	
Sistolic Blood Pressure rest (mmHg)	126.5 ± 10.2	
Diastolic Blood Pressure rest (mmHg)	68.8 ± 9.9	
HRrest (bpm)	65.3 ± 12.8	
HRpeak-test (bpm)	188.4 ± 10.7	
VO_2peak-test (ml/kg/min)	38.9 ± 3.4	
Variable	Alternate	Simultaneous
Average HR (bpm)	160.38 ± 16.24	166.25 ± 12.5
% HR	85.15 ± 7.10 %	88.29 ± 5.14 %
Average VO2 (ml.kg-1.min-1)	29.74 ± 5.31	30.96 ± 6.88
% VO_2	76.52 ± 12.71 %	79.58 ± 15.58 %

Note. VO_2 peak = peak oxygen uptake; HR peak: heart rate peak VO_2 peak reached in a session

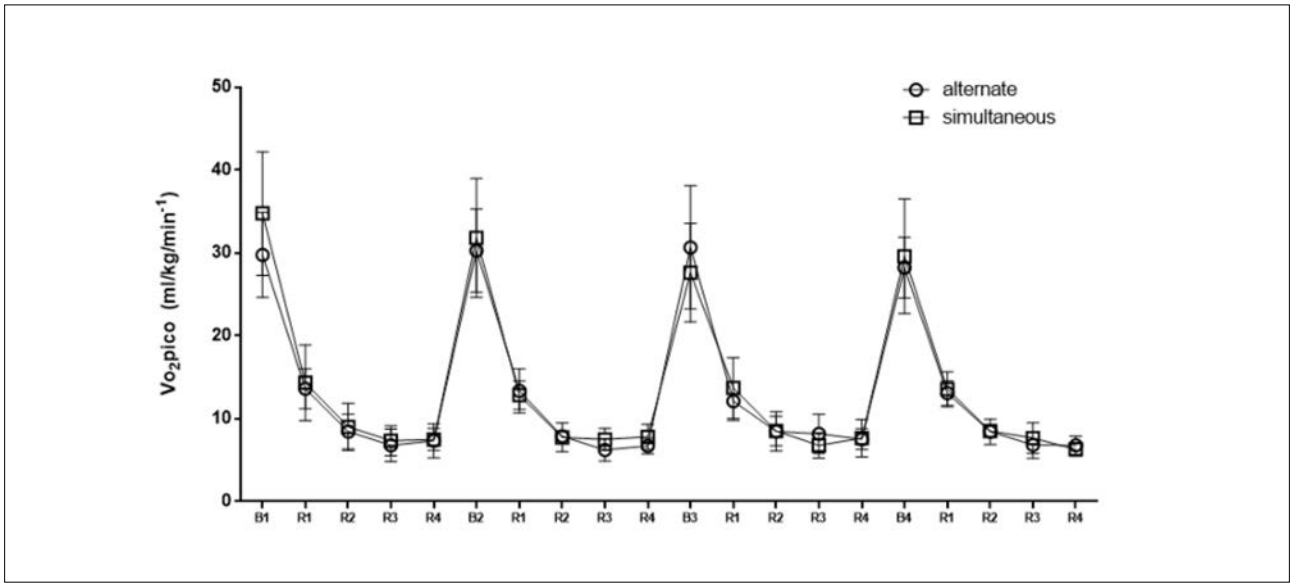

Figure 1
VO_2 peak analysis (direct measurement) during sprints on different battling rope strategies. □ - simultaneous; ☐ – alternate. B – Sprint bout; R – Passive Recovery. HRpeak reached in a session.

difference ($p = .67$) between the strategies and effect size $\eta^2 = .704$, considered moderate

Figure 2 shows the HR peak response reached during the four sprint interval bouts. The HR peak averages during each bout were 156 ± 18.60 vs. 162.37 ± 14.83 bpm ($p > .99$) in bout 1; 159.12 ± 17.70 vs 164.50 ± 12.82 ($p > .99$) in bout 2; 166.25 ± 12.83 vs 168.37 ± 12.18 bpm ($p > .99$) in bout 3, and 166.25 ± 12.83 vs 169.37 ± 12.18 bpm ($p > .99$) in bout 4 during alternating and simultaneous conditions, respectively. The session average was 85.15 ± 7.10% (alternating arms) and 88.29 ± 5.14% (simultaneous arms). The ANOVA repeated measurements showed that there was no significant chronotropic difference between strategies (p = .99) and effect size η^2=1.638, considered large.

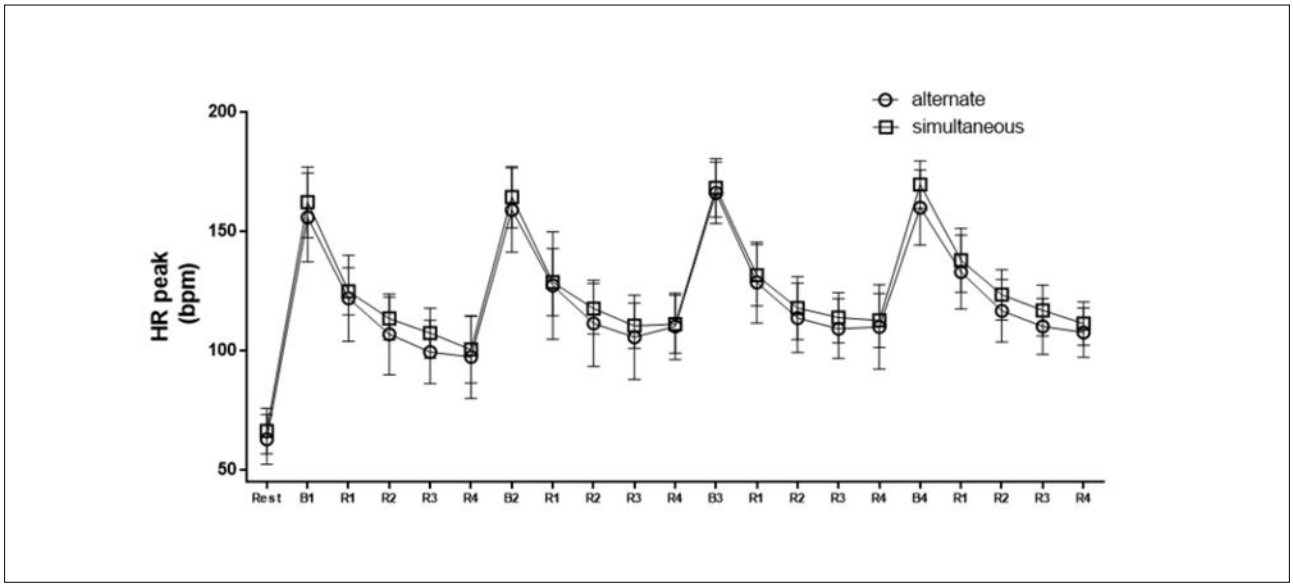

Figure 2
HR analysis during sprints on different battling rope strategies. □ - simultaneous; ☐ – alternate. B – Sprint bout; R – Passive Recovery.

Discussion

The main purpose of this study was to compare the HR and VO_2 responses elicited by a BRP in simultaneous and alternating movements. Our main findings were that HR and VO_2 responses during simultaneous and alternating movements were not different between exercise modes.

The results of the present study demonstrated that HR and VO_2 produced a mean value of 166 ± 12 and 160 ± 16 bpm, which corresponded to 88.29% and 85.1% % HR peak, respectively, and a mean of 30.96 ± 6.88 and 29.74 ± 5.31 $ml.kg^{-1}.min^{-1}$, corresponding to 79.58% and 76.52% of VO_2 peak, respectively, for alternating and simultaneous movements. These behaviors are similar to those of previous studies, showing higher VO_2 and HR in response to BRP exercise. Fountaine and Schmidt (2015) analyzed the mean HR peak and VO_2 peak during a sprint session of battling rope with simultaneous movements (10x15 s all out, 45 s recovery). They found peak HR as a percentage of 94% HR peak (178 bpm) and average VO_2 peak of 35.4 $ml.kg^{-1}.min^{-1}$. A similar finding was reported in a study by Brewer et al. (2018), who analyzed the influence of the simultaneous BRP in seated and standing positions. They found peak HRs as a percentage of the maximum of 93% and 92% and 67% vs. 65% of VO_2 peak, with no significant difference between positions.

Conversely, Ratamess et al. (2015) identified moderate intensities (24.6 $ml.kg^{-1}.min^{-1}$ – 50%VO_2 peak) with the effect of a battling rope session (3 × 30 s/2 min), using different movement techniques (alternate, simultaneous, and simultaneous with jumping) throughout the sprint. In another study by the same authors, Ratamess et al. (2015) compared the metabolic effects of different recovery times (1 min vs. 2 min) during a 30 s stimulus using alternate and simultaneous movements (15 s + 15 s). They found that lower intervals increased the metabolic demand (72 – 75.5% vs. 67.9 – 69.6% VO_2 peak) when compared to the larger ones. Faigenbaun et al. (2018) analyzed the cumulative effect of five different oscillation techniques during a 10-min protocol [5x (2x 30 s all out, 30 s recovery)]. The HR peak and VO_2 peak showed a progressive increase with the level of movement effort, as in our study, and this reached moderate and vigorous intensities, varying between 52.9% – 86.4% (109 – 168.9 bpm) and 21.5 – 67.8% (10.3. 30 $ml.kg^{-1}.min^{-1}$).

As we can see in the results above, there is substantial heterogeneity between the protocols and an apparent association between the lower recovery time (<45 s) and the highest metabolic demand. However, it is possible to identify that the results are independent of the type of protocol or execution condition (alternate or simultaneous). The battling rope exercise facilitates the reach of vigorous and moderate levels of intensity, complying with the recommendations of ACSM, by being capable of important cardiovascular and neuromuscular adaptations to obtain better indices of maximal aerobic power. The potential benefits of battling rope exercise were presented in a recent research paper by Chen et al. (2018). The researchers studied the effect of an 8-week intervention with battling rope and observed significant improvements over core localized muscular resistance, aerobic capacity, and upper body power.

Although our results are exciting, there are some limitations to the present study. First, we did not use a metronome to standardize the repetitions or velocity for each exercise. Second, the participants had only one session in each form, and we did not verify the reproducibility of the results. Finally, we had a reduced number of volunteers and only included young male adults without familiarity of exercise method. Thus, future work is needed to investigate the acute and chronic effects of the movement variation in battling rope for different gender and age groups, controlling the number of movements per stimulus.

Conclusion

This study showed that there is no difference in the acute cardiovascular response of BRP exercise involving different modes (alternated or simultaneous). Moreover, according to ACSM, these results suggest that the intensity generated during BRP exercise can be sufficient to improve and/or maintain maximal oxygen uptake in healthy people.

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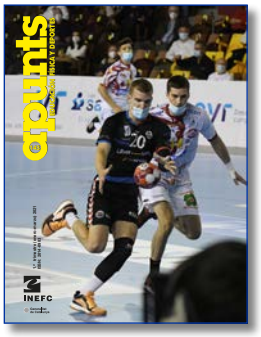
Conflict of Interests: No conflict of interest was reported by the authors.

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 143

Published 01 January 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.01



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International Competition Kinematic Demands in Men's Field Hockey

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Cite this article:
Haro, X., Torres, L., Casamichana, D., Romero-Moraleda, B., Morencos, E., & Rodas, G. (2021). International Competition Kinematic Demands in Male Field Hockey. *Apunts. Educación Física y Deportes*, *143*, 90-99. https://doi.org/10.5672/apunts.2014-0983.es.(2021/1).143.10

Editor:

ISSN: 2014-0983

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Section:
Physical Preparation

Original language:
Spanish

Received:
18 April 2020

Accepted:
24 September 2020

Published:
1 January 2021

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

The objective of this research was to describe kinematic characteristics during international men's field hockey matches. Sixteen players (age: 25.12 ± 3.66 years; height: 177.12 ± 4.96 cm; weight: 72.45 ± 5.01 kg; caps: 79.12 ±78.96) belonging to the Spanish national team were monitored by means of Global Positioning Systems (GPS) and accelerometry in the course of five matches in the 2017 European Championships. The analyses were performed by game quarter (Q1, Q2, Q3 and Q4), positions (defenders, midfielders and forwards) and minutes played (per match). The data analysed included distances, accelerations and decelerations in different ranges of intensity. Defenders presented less high-intensity kinematic activity (speeds, number of sprints, metres/min) as opposed to midfielders and forwards. The by-quarter analysis showed that Q1 featured the highest kinematic activity for all positions. With regard to minutes played, the cluster analysis placed the players in three groups (<37, 37-48 and >48 minutes). The players who played <37 minutes travelled the largest amount of metres sprinting (>21 kph) and m/min as compared to other groups, whereas those who played between 37-48 minutes travelled the greatest distance at high-intensity (>16 kph) and performed the greatest number of sprints. The study results show that the physical demands on elite field hockey players depend on their position on the field and playing time, with greater activity in Q1 and with less relative high-intensity kinematic activity in players who play most minutes during the match.

Keywords: GPS, hockey, team sports, movement analysis, competition analysis.

Introduction

Field hockey is a team support involving 11 players per side, usually classified in four positions: goalkeeper, defenders, midfielders and forwards. Games involve alternating periods of different intensities, high speeds and high neuromuscular demand (the main ones being sprints, changes of direction, accelerations/decelerations) and lower-intensity periods (walking, trotting) (Jennings et al., 2012). Therefore, players are required to have certain conditional capacities, besides high technical and tactical skill (Jennings et al., 2012; Lythe & Kilding, 2011; Spencer et al., 2004).

In recent years, the sport has undergone major changes both in its rules and in the evolution of equipment which have had an enormous influence on the way the actual game is played (White & MacFarlane, 2015). One of the most important modifications was in total playing time and its new distribution, which as of the 2014-2015 season changed from two 35-minute halves to four 15-minute quarters (International Hockey Federation, FIH; 2014).

The use of global positioning systems (GPS) and accelerometry during training and competition is now very common in many sports, and more specifically in field hockey it has increased in recent years (Cummins et al., 2013; Vescovi & Frayne, 2015; White & MacFarlane, 2015). Since the use of such devices is permitted during official FIH matches, rapid progress is being made in knowledge of the sport (Aughey, 2011; Polglaze et al., 2017) which is key to ascertaining its kinematic demands in competition and in making progress in adapting training to the demands of competition, even rendering it possible to analyse and manage training load in real time in competition (Gabbet, 2010; Ishan et al., 2017; Polglaze, et al., 2017; White & MacFarlane, 2015).

The use of technology in field hockey for monitoring purposes has commonly focused on recording and analysing variables pertaining to movement: total distance, mean and maximum speed and movements in the different speed ranges (Lythe & Kilding, 2011; Polglaze et al., 2017). Nevertheless and as noted above, accelerations, decelerations and changes of direction occur frequently and contribute substantially to players' energy and more particularly neuromuscular demands, whereby it is important that they be taken into account as well (Spencer et al., 2004).

Previous studies have shown that in the course of a competitive match players can perform more than 900 acceleration and deceleration actions (Morencos et al., 2018). Average total distance travelled in international men's hockey matches is lower in comparison with football or Australian rules football (5,824-10,160 m, 9,000-12,000 m, 11,880-12,310 m, respectively), although the relative intensity is higher (131m·min-1, 111m·min-1, 109m·min-1, respectively) (Polglaze et al., 2017; Taylor et al., 2107). These differences may be ascribed to factors such as unlimited substitutions, which can be made without interrupting play, as well as to a greater proportion of available reserve players ($n=6$) for active players ($n=10$) meaning that the demands of competition can be spread out over more players.

Previous research into changes in the rules had already stressed the description of the kinematic demands in this sport. For example, Polglaze et al. (2017) presented position-specific data with the old rules of the game: forwards travelled an average of 5,409 ± 689 m in the 41:57 ± 5:23 minutes that they played. Defenders travelled an average of 6,257 ± 909 m in the 52:04 ± 7:12 minutes that they played, and finally midfielders travelled an average of 6,292 ± 855.5 m in the 46:11 ± 5:51 minutes that they played. However, in Jenninngset et al. (2010) this relationship between distance travelled and intensity according to position on the field changes: forwards travelled an average of 9,819 ± 720 m with 2,189 ± 456 m at high intensity (>15 kph). Midfielders travelled an average of 10,160 ± 215 m, with 2,554 ± 134 m at high intensity, and finally, defenders travelled an average of 9,453 ± 579 m with 1,734 ± 177 m at high intensity. In this case, the midfielders covered the greatest total distance and at high intensity.

The studies conducted following the new playing time distribution show that in the international game, forwards cover the greatest distance at high intensity (3,090 ± 565 m) compared to midfielders (2,680 ± 360 m) and defenders (2,257 ± 498 m). As for total distance travelled, once again forwards cover the greatest distance followed by midfielders and defenders, respectively (Ihsan et al., 2018). According to Lombard et al. (2017), forwards travelled an average of 5,159 ± 1,194 m, of which 29.7% was at high intensity (14.1 – 19 kph). Defenders travelled an average of 6,220 ± 1,797 m, with 17.9% at high intensity, and midfielders travelled 6,256 ± 1,859 m, 25.6% at high intensity. In their analysis, the relationship between distance travelled and playing time was 178.3 ± 22.3 m and 29.2 ± 8.6 minutes of play for forwards, 134.4 ± 16.6 m and 47.3 ± 14 minutes of play for defenders and 160.0 ± 5.6 m and 39.6 ± 12.6 minutes of play for midfielders. In terms of metres per minute, forwards travelled 178.3 ± 22.3 m, defenders 134.4 ± 16.6 m and midfielders 160.6 ± 15.6 m. In this case, total distance and playing time diminish with the new playing time distribution, although mean intensity and the percentage of distance travelled at high intensity increase.

Few studies have been conducted with the new times format, which is why it is important to continue to provide information about kinematic demands in competition in this sport since the demands of competition need to be

understood thoroughly in order to prepare players better during training.

Therefore, the objective of this study was to analyse and describe international competition kinematic demands in men's field hockey (Spanish national men's team) with particular emphasis on positions, match quarters and minutes played in competition.

Methodology

Participants

Sixteen field players (age: 25.12 ± 3.66; height: 177.12 ± 4.96 cm; weight: 72.45 ± 5.01 kg; caps: 79.12 ± 78.96) of the Spanish men's field hockey team participated in the study (Table 1). This study was approved by the Scientific Research Ethics Committee (CREC) of the Consejo Catalán del Deporte of the Government of Catalonia under number 18/CEICGC/2017. For data collection purposes the participants were informed directly and agreed to participate voluntarily by signing the informed consent form.

Procedure

The players were monitored in the course of five matches of the 2017 European Championships held in the Netherlands ($n = 78$ cases). The goalkeepers were excluded from the study due to the number of devices available. Three matches corresponded to the group phase and two matches to the play-offs for the 5th to 8th places. For the by-position analysis, the players were grouped into defenders ($n = 6$, 28 cases; there were two matches in which one player did not play any minutes for tactical reasons), midfielders ($n = 5$, 25 cases) and forwards ($n = 5$, 25 cases).

The total match time (60 minutes) and the time of each of the 15-minute match quarters (Q1, Q2, Q3 and Q4) were used for the analysis. The activity of the players on the field (actual playing time) was analysed, excluding the breaks between quarters or when the players were on the substitutes' bench, either for technical reasons or temporary yellow cards. The matches were played with break periods of 36-48 hours between each match.

Monitoring was performed by means of GPS devices (Wimu® model v1.6, RealTrack Systems, Almería, Spain) which operate with a sampling frequency of 10 Hz. This device complies with the IMS standard as provided for in the FIFA quality programme for electronic performance and tracking systems (EPTS). According to Macfarlane et al., (2016), 10 Hz devices appear to be more valid than 1 Hz and 5 Hz devices. The rate of satellites connected to each unit was maintained between three and 11 throughout the Championship. Moreover, among other features each unit has an accelerometer and gyroscope of 100 Hz. The unit was fitted to a harness designed specifically for this purpose and the device was placed between the shoulder blades. All of the players occupied the same position in the five matches and used the same GPS unit in order to minimise inter-device variability (Jennings et al, 2010). With regard to intra-device precision, Wimu® has a proven precision of between 0.69% and 6.05%, a test-retest reliability of 1.47 and an inter-unit precision of 0.25 (Bastida et al., 2018). However, and related to the foregoing, a greater number

Table 1
Characteristics of the study participants.

	$n = 6$	$t = 5$	$t = 5$	$t = 6$
	Defenders	Midfielders	Forwards	Totals
	mean SD	mean SD	mean SD	mean SD
Weight (kg)	73.48 ± 5.75	71.38 ± 2.86	72.3 ± 6.45	72.45 ± 5.01
Height (cm)	179 ± 4.04	172 ± 2.91	180 ± 3.87	177.12 ± 4.96
Age (years)	24 ± 3.4	27.4 ± 3.97	24.2 ± 3.27	25.12 ± 3.66
Caps (number)	70.66 ± 96.01	106.8 ± 83.64	61.6 ± 58.45	79.12 ± 78.96

of errors has been reported as movement speed increases (Linke et al., 2018).

Subsequently, the data from each GPS were downloaded using the SPro® software (v 1.0.0 Compilation 933, RealTrack Systems, Almería, Spain). Once the data had been filtered through the software they were input into a personalised spreadsheet (Microsoft® Excel® for Mac, v 14.7.1).

The variables recorded for subsequent analysis (Table 4) were: minutes played (min; MP), total distance (m; TD), peak speed (km·h^{-1}), distance travelled at high-intensity (DHI: >16 km·h^{-1}), distance travelled at high intensity per minute (DHI/min), total distance per minute (m/min total), distance per minute played (m/min played), number of sprints (>21.0 km·h-1 for more than 1 second), number of sprints per minute (sprints/min), and number of accelerations (Acc) and decelerations (Dec) analysed in 3 intensity categories: low (Z1: 1-2.5 m·s^{-2}), moderate (Z2: 2.5-4 m·s^{-2}) and high (Z3: >4 m·s^{-2}). All the variables except peak speed were expressed in absolute terms and according to minutes of play (MP; m·min-1 or n·min-1). The "work:rest (W:R)" ratio was established, dividing the distance travelled >6 km·h^{-1} / distance <6 km·h^{-1} to establish work density.

Data analysis

A dataset analysis was performed and the data were presented as means and standard deviations (±SD) with a 95% confidence interval (CI) and effect size (ES). A two-way ANOVA was used to ascertain differences by positions and by quarters (positions x quarters). A cluster analysis was performed to establish groups according to the minutes played variable, with three groups established according to: <37 min, 37-48 min and >48 min (Table 2). The thresholds for the ES were <0.2; 0.2–0.6 (trivial), 0.6–1.2 (small), 1.2–2.0 (moderate), 2.0–4.0 (large) and 2.0–4.0 (very large) (Hopkins, 2002). All the statistical analyses were performed using the SPSS 18.0 statistics package for iOS and the level of significance accepted was $p<0.05$.

Results

The analysis showed that total distance was 5.18% greater for midfielders versus defenders and 5.12% with regard to forwards (ES: 0.29). Defenders presented less high-intensity kinematic activity (speeds, number of sprints, metres/min) as opposed to midfielders and forwards. With regard to distance at high speed (>16 km·h^{-1}), forwards covered most metres (1,066.89 ± 250.56), 22.77% more than defenders and 0.6% more than midfielders (ES: 0.13) (Table 3). Sprint distance (>21.0 km·h^{-1}) was also greater for forwards and midfielders than for defenders (+49.41%; ES: 0.06 and +1.41%, respectively), with defenders presenting fewer demands in terms of total amount and in terms of total number of minutes played (figures 1C and 1D). The W:R ratio was greater for forwards than for defenders in Q3 and Q4 (Figure 1E). The acceleration and deceleration variables pertaining to time played (minutes) in Z1 were around 23% greater for those who played less than 37 minutes versus those who played more than 48 minutes (Table 3). This tendency towards a greater effort related to minutes played was repeated in each of the three acceleration and deceleration areas established.

In the by-quarter analysis, there was greater kinematic activity in Q1 for all positions. Only the acceleration variables in Z1 and Z2 and decelerations in Z1 fell in Q4 versus

Table 2
Amount of players per playing time and position cluster.

	Match 1			Match 2			Match 3			Match 4			Match 5		
	0-37min	>37 <48	>48	0-37min	>37 <48	>48	0-37min	>37 <48	>48	0-37min	>37 <48	>48	0-37min	>37 <48	>48
FOR	3	2	0	4	1	0	3	2	0	3	2	0	4	1	0
MID	2	3	0	2	2	1	2	2	1	2	3	0	2	3	0
DEF	2	1	3	2	1	3	3	1	2	1	1	3	2	0	3
TOTAL	7	6	3	8	4	4	8	5	3	6	6	3	8	4	3

DEF=defenders; MID=midfielders; FOR=forwards

Table 3
Comparison of kinematic variables according to minutes played.

	MP	N				ES		95% CI	
	0-37min	38	80.25	±	14.20			75.59	84.92
m/min (total)	>37 <48	27	97.51	±	8.56	*1.41		94.12	100.90
	>48	13	100.48	±	8.14	*1.55	.35	95.56	105.41
	0-37min		8.33	±	3.67			7.12	9.54
Distance sprinted/min	>37 <48		8.11	±	2.81		.06	7.00	9.22
	>48		4.33	±	2.20	*1.18#1.43		3.00	5.67
	0-37min		210.39	±	36.01			198.55	222.22
m/min (played)	>37 <48		168.57	±	18.06	*1.4		161.42	175.71
	>48		135.52	±	15.28	*2.32#1.91		126.29	144.76
	0-37min		30.72	±	9.77			27.51	33.93
DHI/min	>37 <48		25.26	±	6.97	*.62		22.50	28.02
	>48		15.62	±	6.75	*1.65#1.39		11.55	19.70
	0-37min		875.05	±	296.20			777.69	972.41
DHI	>37 <48		1076.84	±	263.20	*.71		972.72	1180.96
	>48		834.56	±	323.01	#.85	.13	639.37	1029.76
	0-37min		5890.96	±	1035.71			5550.53	6231.40
Total Distance	>37 <48		7170.19	±	573.23	*1.46		6943.43	7396.95
			7334.85	±	578.54	*1.53	.29	6985.24	7684.46
	0-37min		17.61	±	4.14			16.24	18.97
Acc/min Z1	>37 <48		15.58	±	2.05	*.6		.40	14.77
	>48		13.56	±	1.23	*1.1	1.10	.34	12.82
	0-37min		3.37	±	.89			3.08	3.66
Acc/min Z2	>37 <48		2.97	±	.45		.53	2.79	3.15
	>48		2.69	±	.46	*.84	.62	2.42	2.97
	0-37min		.70	±	.28			.60	.79
Acc/min Z3	>37 <48		.69	±	.17		.64	.62	.75
	>48		.53	±	.18		.65//.92	.43	.64
	0-37min		15.59	±	4.12			14.24	16.94
Dec/min Z1	>37 <48		14.13	±	1.69		.44	13.46	14.80
	>48		12.07	±	1.40	*.96	1.28	11.23	12.92
	0-37min		2.82	±	.76			2.57	3.07
Dec/min Z2	>37 <48		2.32	±	.41	*.78		2.16	2.48
	>48		2.22	±	.24	*.92	.33	2.08	2.37
	0-37min		.82	±	.28			.73	.91
Dec/min Z3	>37 <48		.74	±	.24		.30	.64	.84
			.65	±	.16		.66//.41	.56	.75
	0-37min		1.37	±	.41			1.23	1.50
W:R	>37 <48		1.66	±	.28	*.8		1.55	1.78
	>48		1.21	±	.22	#1.71	.43	1.07	1.34
	0-37min		502.53	±	133.64			458.60	546.45
Acc Z1	>37 <48		664.22	±	69.53	*1.45		636.72	691.73
			738.31	±	82.66	*1.91	1.00	688.36	788.26
	0-37min		96.63	±	28.63			87.22	106.04
Acc Z2	>37 <48		126.22	±	15.70	*1.22		120.01	132.43
			146.23	±	25.86	*1.77	1.03	130.60	161.86

Table 3 *(Continuation)*
Comparison of kinematic variables according to minutes played.

	MP	N				ES		95% CI	
	0-37min		20.37	±	9.28			17.32	23.42
Acc Z3	>37 <48		29.44	±	6.76	*1.1		26.77	32.12
			28.54	±	8.14	*0.9	.12	23.62	33.46
	0-37min		447.55	±	139.44			401.72	493.38
Dec Z1	>37 <48		603.41	±	59.38	*1.37		579.92	626.90
	>48		657.00	±	87.67	*1.63	.70	604.02	709.98
	0-37min		80.63	±	22.33			73.29	87.97
Dec Z2	>37 <48		99.56	±	16.84	*.93		92.90	106.22
	>48		120.46	±	11.88	*1.96#1.35		113.28	127.64
	0-37min		23.79	±	9.86			20.55	27.03
Dec Z3	>37 <48		31.67	±	9.72	*.09		27.82	35.51
	>48		35.23	±	8.88	*.11	.37	29.86	40.60
	0-37min		238.32	±	112.99			201.18	275.46
Distance sprinted	>37 <48		341.59	±	106.46	*.93		299.48	383.71
	>48		233.06	±	108.17	#1.01	.04	167.70	298.43
	0-37min		20.89	±	8.51			18.10	23.69
No. sprints	>37 <48		27.37	±	7.36	*.8		24.46	30.28
			18.54	±	8.68	#1.13	.27	13.30	23.78

* Significant differences with 0-37; # Significant differences with >37<48. Acc: accelerations; Dec: decelerations, MP: minutes played; ES: effect size for significant and non-significant values; CI: confidence intervals; W:R: work:rest ratio; DHI: distance at high intensity

Q1 for midfielders and defenders (figures 2A to 2F). The W:R ratio diminished in Q4 versus Q1 for defenders and midfielders (Figure 1E).

Finally, a cluster analysis grouping the players according to MP was performed. Three clusters were obtained: 1) from 0 to 37 minutes, 2) between 37 and 48 minutes, and 3) more than 48 minutes. The players belonging to group 1 (0-37 min.) presented greater values for total relative distance (m/min), distance at high intensity and distance sprinted in comparison with groups 2 (37 to 48 minutes) and 3 (more than 48 minutes): 19.8±5.8% greater than group 2 (37-48 minutes) and 35.5±6.9% more than group 3 (more than 48 minutes). Accelerations and decelerations per minute in Z1 and Z2 were greater for group 1. The W:R ratio was greater for group 2 compared to group 1 (Table 4).

Discussion

The main objective of this study was to analyse and describe international competition kinematic demands in men's field hockey with particular emphasis on positions, match quarters and minutes played in competition. The main findings were: a) there are differences between positions for virtually all of the variables analysed; b) defenders present the greatest reduction in the W:R ratio in the course of the quarters; c) the variable that remains most stable over the game quarters in all positions is distance at high intensity per minute; d) defenders present the greatest reduction in kinematic activity in all the variables compared to defenders and forwards; e) the players who play fewest minutes cover the greatest relative distance with regard to minutes of play, presenting greater intensity; f) Q1 presented the greatest kinematic activity in all the study variables, except in DHI/min, and g) forwards travelled the greatest number of metres at high intensity and made the greatest number of sprints.

Although any comparison with other published studies may be complicated (because different movement analysis techniques were used as well as different GPS devices, a different categorisation of intensity ranges for the speed, acceleration, etc. variables), some of the values found in this paper are higher in some of the aspects studied. For example, and according to previous studies, international hockey players change speed 512 times per match (Buglione et al., 2013), which is equivalent to once every 6.8 seconds of playing time. In this study, the hockey players changed speed more than 1,500 times in the course of a match, either positively or negatively, which is equivalent to a total of 25 times per minute, which constitutes practically 300%

Table 4
Comparison of the kinematic variables with regard to time, match quarters and positions.

		C1	ES	C2	ES	C3	ES	C4	ES
	Position								
m/min (played)	Defenders	175.22 ± 61.36		160.51 ± 35.66		154.71 ± 40.47		156.75 ± 42.53	
	Midfielders	207.65 ± 46.34	.60	189.45 ± 46.53	*.7	191.44 ± 50.70	*.8	184.06 ± 46.35	.61
	Forwards	212.05 ± 37.98	*.7 .10	196.45 ± 37.99	*.97 .16	194.74 ± 32.66	*1.1 .07	192.16 ± 45.58	*.8 .17
DHI/min	Defenders	21.78 ± 17.31		21.93 ± 10.25		18.81 ± 9.78		18.85 ± 10.21	
	Midfielders	27.64 ± 15.92	.35	29.01 ± 9.48	*.7	28.22 ± 9.60	*.97	27.85 ± 7.94	*.97
	Forwards	30.66 ± 20.24	.5//.1	31.03 ± 10.07	*.9 .20	31.54 ± 11.02	*1.22 .32	32.00 ± 12.94	*1.13 .38
Distance sprinted/ min	Defenders	5.92 ± 5.36		5.88 ± 3.99		4.10 ± 3.22		5.05 ± 3.54	
	Midfielders	9.63 ± 4.06	*.77	8.79 ± 4.95	.65	6.91 ± 4.74	.70	8.41 ± 4.67	*.82
	Forwards	10.01 ± 5.34	*.76 .08	9.20 ± 4.68	*.76 .08	9.20 ± 5.09	*1.21 .46	9.41 ± 6.03	*.9 .18
No. sprints/ min	Defenders	0.53 ± .46		0.45 ± .29		0.42 ± .39		.41 ± .31	
	Midfielders	0.76 ± .37	.55	0.72 ± .27	*.9	0.61 ± .31	.53	.66 ± .29	*.83
	Forwards	0.95 ± .47	*.9 .50	0.82 ± .43	*1.02 .09	0.78 ± .45	*.86 .44	.72 ± .33	*.97 .20
W:R	Defenders	1.46 ± .54		1.25 ± 39		1.19 ± .45		1.11 ± .40	
	Midfielders	1.75 ± .50	.55	1.40 ± 34	a .40	1.56 ± .45	*.8	1.33 ± .29	.65
	Forwards	1.79 ± .59	.6//.07	1.44 ± .49	.04//.09	1.72 ± .65	*.9 .30	1.43 ± .46	*.77 .26
Acc/min Z1	Defenders	17.94 ± 7.08		16.13 ± 4.24		14.64 ± 5.02		15.31 ± 5.37	
	Midfielders	17.27 ± 2.25	.12	14.99 ± 3.04	.30	14.88 ± 3.29	a .05	14.35 ± 3.74	.20
	Forwards	19.84 ± 4.19	.32//.76	16.80 ± 4.29	.16//.5	17.97 ± 4.69	*.7#.8	15.65 ± 4.53	.07//.31
Acc/min Z2	Defenders	3.28 ± 1.28		3.08 ± .88		2.98 ± 1.18		2.94 ± 1.27	
	Midfielders	3.54 ± .85	.24	2.94 ± 1.00	.15	2.93 ± .92	.04	2.75 ± .84	.17
	Forwards	3.68 ± .81	.37//.17	3.34 ± .98	.3///.4	3.27 ± .95	.27//.36	2.82 ± .90	.11//.08
Acc/min Z3	Defenders	.60 ± .37		0.74 ± .38		.61 ± .35		.52 ± .24	
	Midfielders	.68 ± .33	.22	0.64 ± .29	.30	.49 ± .21	.41	.49 ± .22	.13
	Forwards	.83 ± .34	.64//.44	0.84 ± .45	.24//.53	.81 ± .32	#1.18 .60	.78 ± .31	*.9#1.08
Dec/min Z1	Defenders	16.36 ± 6.70		14.23 ± 3.83		13.14 ± 4.52		13.32 ± 5.15	
	Midfielders	16.06 ± 2.15	.06	13.00 ± 3.00	a .35	13.25 ± 2.60	a .03	12.20 ± 2.39	.27
	Forwards	17.72 ± 3.72	.25//.55	15.36 ± 3.37	.31//.74	16.16 ± 5.02	*.63#.72	13.98 ± 3.71	.14//.57
Dec/min Z2	Defenders	2.83 ± 1.07		2.52 ± .81		2.47 ± 1.02		2.25 ± .80	
	Midfielders	2.82 ± .63	.01	2.57 ± .90	.05	2.62 ± .85	.16	2.48 ± .78	.30
		2.81 ± .66	.02//.01	2.39 ± .72	.17//.22	2.70 ± .93	.23//.09	2.22 ± .81	.06//.35
Des/min Z3	Defenders	.83 ± .38		.80 ± .29		.64 ± .35		0.70 ± .38	
	Midfielders	.86 ± .49	.07	.66 ± .36	.43	.62 ± .23	.06	0.71 ± .50	.02
	Forwards	.91 ± .39	.2//.11	.80 ± .43	//.35	.82 ± .39	.5//.6	0.82 ± .38	.31//.24

a indicates significant difference with quarter 1. b indicates significant difference with quarter 2. c indicates significant difference with quarter 3; *indicates significant difference with defenders. # indicates significant difference with midfielders (in the same quarter).

more in terms of total accelerations and therefore virtually multiplies accelerations per minute threefold. Besides the possible differences due to the different tools used, match format (4 quarters vs. 2 halves) or player level could explain these differences.

Regarding differences between positions, it should be mentioned that the kinematic demands presented by defenders are lower than those of midfielders and forwards, which concurs with previous work conducted according to the new time distribution (Ishan et al., 2018), and as can be seen in Table 4, in many cases these differences are significant. DHI and sprint would also seem to be influenced by the player's position. Thus, in this research defenders present significantly lower data than midfielders and forwards while

Table 5
Total average 5 matches by positions.

	n=28		*n*=25		*n*=25	
	Defenders		Midfielders		Forwards	
	mean	SD	mean	SD	mean	SD
min played	42.86	13.09	37.28	9.76	33.40	5.77 *
m/total min	88.45	19.35	92.56	10.38	87.92	12.40
m/min played	160.99	40.17	193.15	41.03	198.85	26.07 *
DHI/min	20.19	9.42	28.18	6.96	31.31	9.74 *
Distance sprinted/min	5.25	4.11	8.43	4.65	9.45	5.23 *#
Number of sprints/min	.45	.36	.68	.31	.82	.42 *
Peak speed	25.48	2.81	26.85	1.24	27.46	1.68 *
W:R	1.24	.33	1.51	.33	1.60	.39 *
Acc/min Z1	15.81	4.55	15.37	2.15	17.57	2.90
Acc/min Z2	3.04	.99	3.04	.56	3.28	0.58
Acc/min Z3	.62	.27	.58	.18	.81	.20 *#
Dec/min Z1	14.11	4.38	13.63	1.65	15.81	2.90
Dec/min Z2	2.49	.77	2.62	.59	2.53	.57
Dec/min Z3	.74	.26	.71	.23	.84	.26

* Significant differences with defenders # Significant differences with midfielders

forwards present the highest values in these variables, which concurs with previous studies (Lythe et al., 2011; Jennings et al., 2012; Polglaze et al., 2017; Ishan et al., 2018).

Another factor to be taken into account in game intensity is time played, as has been observed in previous studies (Vescovi & Fraine, 2015). Defenders played the greatest number of minutes (42.86 ± 13.09 min.), whereas midfielders (37.28 ± 9.76 min.) and forwards (33.40 ± 5.77 min.) spent less time on the field. Therefore, there would appear to be a dependent relationship between time played and intensity of actions, since the players who played more minutes had lower values per minute played.

With regard to the comparison between the different match quarters, it should be emphasised that while most of the variables tended towards a reduction, this was not always the case. More specifically, DHI/min for forwards increased with the quarters. However, the number of sprints per minute tended to diminish in all positions. Of the variables studied, 54.5% improved in Q4 versus Q3, whereas the rest (45.5%) worsened. The highest values were always obtained in Q1 and/or in Q2 (Table 4 and figures 1A to 1E and 2A to 2F)

As for minutes played according to the cluster analysis, significant differences were observed in m/min played, DHI/min, distance sprinted and Acc/min Z1, with players who played fewer minutes (0-37 min) presenting greater intensity. By contrast, total distance was greater in players who played more minutes, which may be due to the time/intensity ratio: the longer the playing time the lower the intensity of actions, although the longer the playing time the greater the total amount.

While the movements were measured by the usual methods established for the evaluation of physical demands in hockey (and other team sports), their efficacy as indicators of work and intensity for intermittent activity, which involve frequent changes of speed, is questionable (Polglaze et al., 2017). Real work estimates should include acceleration, which directly and substantially contributes to energy cost. Therefore, in assuming that locomotion occurs at a constant speed, the energy cost of this type of intermittent activity is probably underestimated (Osgnach et al., 2010).

Despite the controversy surrounding the relationship between success in sports and high intensity, teams with a better ranking appear to need to travel less distance at high intensity than poorer-placed teams (Jennings et al., 2012). Nevertheless, a number of studies have demonstrated the importance of high-intensity actions (high-intensity running, sprints) in the final outcome in different team sports. This may be due to players' qualitative level, the team's degree of tactical synchronisations and the match situation on the scoreboard or the time of the season among other factors.

In this respect, the frequency and distribution of accelerations and decelerations appeared to yield a better representation of the internal load of a match or training drill,

since in energy terms they are the most solicited actions in team sports (Ingebrigtsen et al., 2015), whereas measurements based on movement (external load) would appear to underestimate the real cost of intermittent sports such as hockey (Polglaze et al., 2017). Therefore, in order to estimate the load involved in a given drill as precisely as possible, emphasis should be placed on the amount of accelerations and decelerations and on their distribution and accumulation over time as well as their magnitude.

Some of the main limitations of this paper pertain to the number of matches studied and the absence of internal load and technical-tactical information. Knowing the impact of the activity performed by the players on their body would help to calculate cardiovascular efficiency indexes and also make it possible to study its evolution in the course of the match and draw comparisons between positions. Moreover, information could be obtained about the number of occasions in which each player participates on the field as well as the duration of each participation and between participations, also providing more detailed information about the density of efforts made in international men's hockey

Conclusions and practical applications

Knowing the kinematic demands on players during competition is the starting point for designing training drills, managing workloads or monitoring the process of transitioning injured players back into competition. Having competition-specific data will facilitate, for example, the design of conditional priority and low-specificity drills that reproduce the demands of competition in training. Moreover, and with respect to technical-tactical priority drills, the analysis of training kinematic demands and their comparison to competition may help to modify the conditions of these drills in order to adapt them to the conditional reality of competition. In addition, the differences between positions originated by technical and tactical roles and minutes played may help to guide and determine workload size, particularly on after-match days. Distinguishing what and how much to do depending on what has already been done could constitute a personalised recovery strategy depending on the workload accumulated in the match.

Due to the evolution of high-intensity actions in the course of the match quarters in competition, making changes more frequently and having a pre-set rotation that guarantees player recovery may be a strategy to follow in order to ensure that all of them can keep up the same pace of play during a match or a tournament. Having a greater number of forwards in the match squad so that they can be used during the competition, in the knowledge that this position involves the greatest number of high-intensity actions, could be another useful strategy for maintaining or improving their high level of effort.

In conclusion, the results of this study show that the kinematic demands on elite hockey players depend on their position on the field, with greater activity in the first quarter, and with less kinematic activity in players who play most minutes during the match.

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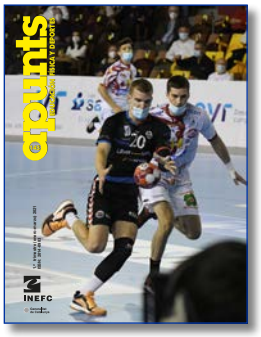
Conflict of Interests: No conflict of interest was reported by the authors.

apunts EDUCACIÓN FÍSICA Y DEPORTES

Published 01 January 2021

ISSUE 143



OPEN ACCESS

Strategy for Methodological Training for the Direct Implementers of the "Educa a tu hijo" Programme (Cuba)

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Date read: 4 December 2017

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Doctoral Dissertations

Original language:
Spanish

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

The research addresses aspects related to the training of the direct implementers of the *"Educa a tu hijo"* (Educate Your Child) Programme, on the grounds that there are methodological constraints which impact the performance of the people concerned. A strategy is therefore proposed for the methodological training of its direct implementers. The system of actions and operations in the strategy allows the direct implementers to be trained to provide more efficient stimulation of the psychomotor development of children aged 0-1 years and also furnishes families with better training in this regard.

The tasks envisaged in the research were performed with the contribution of the 100 direct implementers of the programme and were based on an experimental design.

The information was processed statistically. The methodology made it possible to draw up an operational definition which yielded the principle of the strategy, which is the cross-cutting central theme of the training process for the programme's direct implementers. It constitutes the foundations of the teaching structure, which encompasses the actions designed to stimulate the psychomotor development of children aged 0-1 years, thus enhancing the theoretical concept of advanced education as an alternative educational paradigm for human improvement and the methodological aspects related to the development of psychomotor skills at preschool age.

The results obtained from the theoretical and practical validation of the proposed strategy demonstrate its relevance and potential for implementation to foster the psychomotor development of children in the first year of life.

Its main achievements are an increased knowledge and mastery of skills in implementing actions to stimulate psychomotor development. The conclusions and recommendations reflect the proposal's feasibility and the need to continue to investigate aspects not addressed in depth to find fresh solutions to the problem.

Keywords: stimulation, psychomotor development, training; direct implementers, Educate Your Child Programme.

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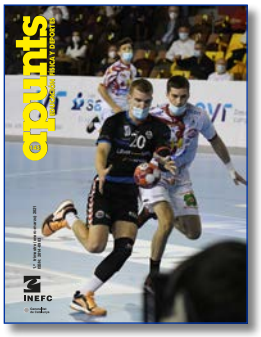
EDUCACIÓN FÍSICA Y DEPORTES

Published 01 January 2021

ISSUE 143



OPEN ACCESS

Methodology for the Teaching-Learning Process of the Routine in Aerobic Gymnastics

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Date read: 4 December 2017

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Doctoral dissertations

Original language:
Portuguese

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

The findings of previous research, the observation of national and provincial competitions, and enquiries addressed to specialists in different regions around the country revealed technical shortcomings in the performance of the routine in aerobic gymnastics, which were mainly: a limited use of transitions, incorrect execution of exercises and lack of coordination between movements and musical rhythm. The routines convey a lack of fluidity and integration and do not tell a story, demonstrating that a better teaching-learning process is called for since, although a national project does exist, there is no methodological instrument to guide teachers. To address this problem, a methodology was designed which includes the components that identify the routine, the essence of which consists of using the steps in the routine as a whole to facilitate teaching based on a flexible, systemic, integrative and contextual conception. An operational definition was drawn up for the research called "Choreographic Design", being the procedure of combining motor actions to create and arrange sequences of movements in space with an internal logic and a certain meaning or intention that are expressed in a corporeal and artistic way. This design fuses movement, displacement, rhythm, body expression, space and style.

The research yielded a system of principles which characterise and underpin the methodology, establishing a distinction between the process of teaching and learning of the routine in this sports activity: the principle of integration of performance and music and the principle of sequentiality. Scientific methods were used to compile information about the initial state of the teaching-learning process of the routine, to design the methodology and to obtain and process the results of the pre-experiment, where better class planning was observed, with its special features taken into account, and in which resources are used to reinforce the message. This helps to understand what is to be achieved and makes it possible to personalise teaching based on the shortcomings of each athlete, as well as contextualisation according to the modality, aspects mainly demonstrated by the fact that the athletes perform the routines properly. According to highly-qualified experts, the results of all the descriptive measures denote a consensus in each one of the indicators assessed. They considered that the proposed methodology is appropriate for implementation in practice. Similarly, the degree of user satisfaction confirmed a receptive attitude among teachers to the methodology applied. These results demonstrate the relevance and viability of the methodology for achieving an effective teaching-learning process for the routine, as expressed in the integration of its components as a new methodological concept.

Keywords: methodology, routine, aerobic gymnastics.

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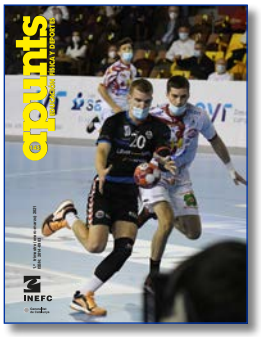
Published 01 January 2021

ISSUE 143



OPEN ACCESS

Formative Assessment in the Acquisition of Teaching Competencies in Initial Physical Education Teacher Training

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Date read: 18 June 2018

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Doctoral Dissertations

Original language:
Spanish

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

This PhD thesis evaluated the relationship between formative assessment during initial Physical Education teacher training and the acquisition of teaching competencies, including the assessment competency. Four specific objectives were proposed: (1) To gauge the graduates' perception of the competencies acquired during their initial training, the utilization of the formative assessment for the acquisition of teaching competencies, the assessment instruments used and the forms of grading used by university teachers during this stage; (2) To ascertain whether there are differences in these objectives depending on the course of study taken, if they are working or not as teachers or have teaching experience; (3) To assess a possible relationship between the implementation of formative assessment, the type of assessment instruments used during initial training, the forms of grading used by university teachers and the graduates' perception of the degree of acquisition of competencies; (4) To ascertain practicing graduates' appraisal of the competencies acquired in their initial training and their perception of the extent to which the formative assessment helped them acquire these competencies.

A quantitative study was developed to address the first three aims of this research. Four hundred and ninety-one (491) graduates in the Primary Education (Physical Education specialty) and Physical Activity and Sport Sciences Degree from 20 Spanish universities participated. A questionnaire on teaching competencies and formative assessment was used. The results show that graduates rate their training in teaching competencies and the use of the formative assessment for this purpose as good, pointing to a predominance of the utilization of multiple-choice exams, written essays and heterograding. Generally speaking, there are no significant differences in the development of teaching competencies and the use of formative assessment for this purpose depending on whether graduates are working as teachers or not or have or do not have teaching experience.

An instrumental case study was developed to address the fourth objective. This study involved 4 graduates from the aforementioned degrees employed as Physical Education teachers in Primary or Secondary education, and three university teachers who engage in formative assessment processes in initial Physical Education teacher training. The information was collected through semi-structured interviews, observation and documentary analysis. The information obtained shows that the graduates positively rate the formative assessment for the acquisition of teaching competencies provided that such processes are implemented systematically and are accompanied by feedback. They also feel that the use of formative assessment during initial training helped them to learn alternative forms of assessment and to have assessment resources which, adapted to their setting, can be used in their classes.

Keywords: formative assessment, physical education, initial training, competencies.

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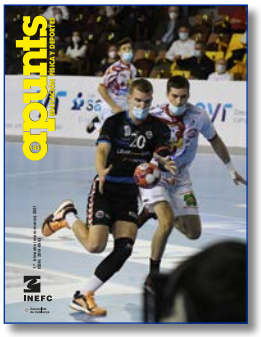
ISSUE 143

Published 01 January 2021



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Reflection-in-Action and Assessment in Physical Education Teachers in Secondary and Intermediate Education: Case Studies in Medellin (Colombia)

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Date read: 29 June 2017

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Doctoral Dissertations

Original language:
Spanish

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/lafototeca.com

Abstract

This study identified and explored conceptions and reflection-in-action in six physical education teachers. It explored the teachers' perception of assessment and its constituent parts (content, stakeholders, times and instruments). It also analysed reflection-in-action in the three teaching stages, i.e. how decisions are made before a teaching unit is started (pre-interactive stage), the nature of the discourse and the reflection-in-action during the lessons (interactive stage), and what kind of reflections arise at the end of the unit (post-interactive stage).

The research presented a qualitative design based on multiple case studies. The strategies used were interviews and video and audio recording of the lessons of a teaching unit, diary and documentary analysis.

The findings show that the teachers' conceptions of assessment are an amalgam of discourses that reflect their wish to accept formative assessment but do not correlate to what was observed in the interactive stage. In their conceptions, teachers see themselves as the main actor in the assessment, and highlight the importance of evaluating procedures, concepts and attitudes. However, when they describing their criteria, the latter focus on attitudes, particularly on behaviour and active participation in the class, and attitudes that reflect values such as teamwork, cooperation, respect and autonomy take something of a backseat.

In relation to their pre-interactive decisions, planning for the assessment does not warrant a great deal of interest from teachers, since their experience affords them the confidence to tackle future units.

Nine subcategories emerged in the evaluative discourse. The assessment of student attitudes, both positive (motivation – congratulations) and negative (criticism – warning), enjoyed prominence, with the information about the actual motor tasks being relegated to third (corrective) and fourth (offering solutions) place. Information that would allow students to internalise learning, be aware of what they are doing and develop their autonomy (argumentative, inquisitive, pointing out mistakes) came in last.

The reflection-in action analysis (interactive stage) was consistent with what was expressed in the conceptions and planning. There was no systematic gathering of information based on specific instruments and criteria.

The teaching staff's thoughts in the post-interactive stage focused essentially on potential changes in certain strategies and instruments. Assessment of their own assessment (meta-assessment) was uncommon, possibly indicating that reflection is not a constant action among teachers or that they lack the skills needed to engage in it.

Keywords: physical education, teacher's thinking, assessment of teaching, assessment of learning, evaluative discourse, meta-assessment.

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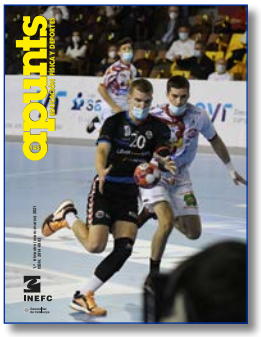
Published 01 January 2021

ISSUE 143



OPEN ACCESS

Between School and University: Analysis of the Process of Substantiation and Systematisation of the Epistemology of Professional Practice in Physical Education Teachers

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Date read: 3 August 2018

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Doctoral Dissertations

Original language:
Spanish

Cover:
Handball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/lafototeca.com

Abstract

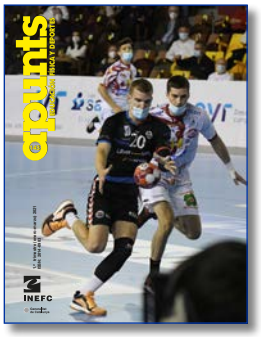
Physical education teaching has swung between the movement that facilitates its professionalisation and the process that proletarises it. Understanding the work of teachers from the standpoint of professionalisation calls, among other things, for the substantiation of the knowledge which can provide the foundations for the profession, in turn requiring new relationships between the academic and educational domains. In this regard, the objective was to investigate the process of constructing the paradigm of the epistemology of the practice of physical education teachers, which would be substantiated by and systematised on the basis of the knowledge that emerges from teaching practice and professional education. To this end, a qualitative approach divided into two stages was chosen. In the first stage, the understanding of practice was analysed from the point of view of seven educators from six Brazilian universities. The data were sent for content analysis using the NVIVO software and were presented in two areas: the main objectives of teaching practice and professional intervention; and the main options for the practice of epistemology in the academic and professional domains. The second stage addressed the professional field, based on three procedures. Initially, a survey was carried out with a sample of 97 teachers to perform a diagnosis of the situation. Six teachers were subsequently chosen for a study of the in-depth stage based on observing lessons, recording actions, using the self-confrontation technique and conducting interviews about their life journeys. The data were then sent to be studied. Analysis of practice seems to be an important strategy for the re-signification of teachers' actions through reflective processes that can lead to the transformation of the professional *habitus* and consequently to a substantial change in the way they do things. The main building blocks of the teaching process are to be found in professional practice. As a result, and although many challenges remain, the visions of practice in the professional field of physical education need to be re-signified, as it is important to understand that the knowledge of teachers and professional *habitus* must be in synch with the movement towards the professionalisation of teaching.

Keywords: epistemology of practice, teacher training, teaching practice, teaching knowledge, professionalisation of teaching.

apunts EDUCACIÓN FÍSICA Y DEPORTES

Published 01 January 2021

ISSUE 143



ICT in the Learning of Physical Education by Secondary School Students in Pampas de Hospital (Peru)

Oscar Calixto La Rosa Feijoo*
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Date read: 30 June 2016

OPEN ACCESS

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació Física de Catalunya (INEFC)

ISSN: 2014-0983

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Section:
Doctoral Dissertations

Original language:
Spanish

Cover:
HHandball Spain: Ademar León and Liberbank Sinfín play the first match with masks during a Sacyr Asobal league game in October 2020, to comply with the regional regulations of COVID-19. J.Casares/(EPA) EFE/ lafototeca.com

Abstract

This paper discusses the influence of ICT on the learning of the physical education subject by secondary school students in the Pampas de Hospital district (Tumbes). It principally examines the importance of ICT in physical education learnings, which must be acquired and internalised if they are to be applied in the course of life. The thesis was conducted using the quantitative-experimental approach, which places great stock on the use of a medium which could help to improve learning by secondary education students at the Alipio Rosales Camacho and Horacio Zeballos Gámez schools. The sample comprised two groups with similar features, the experimental group (EG) and the control group (CG), with a total of 92 students in the first year of secondary school aged 11-12 years (both groups had 46 students). A pre-test with two questionnaires was applied, one on their knowledge of ICT and the other one on their knowledge of the physical education subject, it transpiring that their level of knowledge of the research variables and the results were quite similar. This was followed by the experimental phase, which consisted of using ICT in teaching the theoretical part of each topic of the PE subject to the EG alone, after which both groups were evaluated with a post-test. The questionnaires used in the pre-test were administered for this purpose. The results obtained were very different: an improvement in the learning of ICT- and PE-related knowledge was observed in the EG compared to the CG, in which not much difference was observed. The hypothesis was tested using Student's t-distribution. The research proves the hypothesis, as the results obtained show that using ICT in PE lessons increases learning in this subject's topics, as endorsed by the results percentages shown.

Keywords: ICT, learning, physical education.