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ORIGINAL

EFFECT OF PROPRIOCEPTIVE EXERCISE ON BALANCE IN YOUTH SPEED SKATERS

EFECTO DEL EJERCICIO PROPIOCEPTIVO SOBRE EL EQUILIBRIO EN PATINADORES DE CARRERA JUVENILES

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ABSTRACT

The research aimed at determining the effect of a proprioceptive exercise program on balance in youth speed skaters. A quasi-experimental study was conducted. Three skating clubs were randomized, two clubs were the control groups and one was the experimental group. 49 young people of both genders between 11 and 15 years participated. The proprioceptive exercise program was applied to the experimental group, and the control received a conventional training program. A stabilometric test was performed, levels of stability, amplitude and frequency of oscillations and static balance were measured. Both groups improved balance frequency in both directions, with eyes open and closed (p<0.050). Neither the levels of stability and balance amplitude nor static balance showed significant changes (p>0.050). No significant differences were found in the measures of change between groups in any of the variables studied (p>0.050).

KEYWORDS: Postural balance; Exercise; Propioception; Skating; Child and adolescent.

RESUMEN

El objetivo del presente estudio fue determinar el efecto de un programa de ejercicio propioceptivo sobre el equilibrio en patinadores de carrera juveniles. Se realizó un estudio de alcance cuasiexperimental. Se aleatorizaron tres clubes de patinaje, dos al grupo control y otro al experimental. Participaron 49 jóvenes de ambos sexos entre 11 y 15 años. Al grupo experimental se le aplicó un programa de ejercicio propioceptivo, mientras el grupo control recibió un programa de entrenamiento convencional. Se realizó una evaluación estabilométrica, se midieron los límites de estabilidad, la amplitud y frecuencia de oscilaciones y el equilibrio estático. Ambos grupos mejoraron la frecuencia de balanceo en ambas direcciones, con ojos abiertos y ojos cerrados (p<0,050). Ninguno de los límites de estabilidad y amplitud de balanceo, así como el equilibrio estático evidenciaron cambios significativos (p>0,050). No se encontraron diferencias significativas en las medidas de cambio entre grupos en ninguna de las variables estudiadas (p>0,050).

PALABRAS CLAVE: Balance postural; Ejercicio; Propiocepción; Patinaje; Niño y adolescente.

INTRODUCTION

Speed skating is a modern, entertaining sport with high competitiveness. In Colombia it has become massive and is currently a world force (Bohórquez, 2014; Bernal, 2018). Skating involves adapting the body to move in a particular and unnatural way. The support is reduced; thus, its support base is small, and projected onto the surface of four fixed wheels in line. They slide over the surface of the ground drawing a straight line in an oblique direction to the advance, this produces continuous changes in balance and a greater degree of instability compared to other sports. Coordination and balance are associated with technical execution and sports efficiency, so they are essential elements in sports training (Cenizo, Ravelo, Morilla y Fernández, 2017).

In skating, the postural control system is important, it is guided by external stimuli perceived through visual, vestibular and somatosensory afference. The information is collected by proprioceptive receptors which detect the body's sway movement by providing coordinated muscle activation to maintain postural control. Balance in speed skating improves motor skills and relies on conditional ability of strength, it is responsible for modifications of resting state or movement (static balancing or dynamic balancing) as the body is at a given time. Previous research shows how balance training can be a valuable complement to usual training of athletes who are not elite to improve certain motor skills (Chapman, Needham, Allison, Lay y Edwards, 2007; Guimaraes-Ribeiro, Hernández-Suárez, Rodríguez-Ruiz y García-Manso, 2015; Hrysomallis, 2011).

The proper technique of roller-skating races is based on achieving maximum efficiency and efficiency of strength applied to the skate during push-off, glide and repository or landing phases during the curve or straight line, departure or arrival. Thus, the body moves continuously to the center of gravity according to the requirements, so adequate sensor-motor control is permanently needed (Moreno-Alcaraz, López-Miñarro and Rodríguez-García, 2012; Pérez, Sobrino, Estrada and Chillón, 2014) and an exact movement of the center of mass within the limit of stability, which requires a great sense of balance (Lamort y Van Heuvelen, 2012).

In skating, it is important to carry out proprioceptive training as a strategy to allow perception, awareness, postural reactions, automation and acceleration of movement to improve strength, coordination, balancing and reaction time to a destabilizing event or a movement suggested by the sport (Romero-Franco, Martínez-López, Lomas-Vega, Hita-Contreras and Martínez-Amat, 2012).

During sports practice there are multiple changes in direction and position that demand proprioceptive mechanisms of the skater (Romero-Franco, Martínez-Amat and Martínez-López, 2013). It is precisely the unbalanced process that skates incite that makes skating an attractive and motivating activity, as well as an ideal means for developing coordination capabilities, especially balancing (Domínguez, Lezeta, y Espeso, 2001). Thus, proprioception is the best sensory source to provide the information needed to mediate neuromuscular control and to improve functional joint stability (Benítez-Sillero y Poveda-Leal, 2010; Hagert, 2010; Riemann, Myers y Lephart, 2002; Riemann y Lephart, 2002).

With regard to early-age training, when balance control maturation occurs, it is important to focus processes on developing motor skills, rather than conditional capabilities (Barrera y Ramírez-Villada, 2018). Hormonal changes affect the improvement of strength, and the ability to store engrams, so it is necessary to work on developing new movement patterns (Cárdenas, Burbano y Espitia, 2019).

Speed skating training generally emphasizes conditional qualities such as muscle strength, power, speed and aerobic endurance, underestimating the importance of coordinating qualities, and especially postural stability with its dynamic and static component. This includes sensory information obtained from somatosensory, visual and vestibular systems, and motor responses that affect coordination, joint range of motion and strength (Bressel, Yonker, Kras y Heath, 2007).

The research aimed at determining the effect of a proprioceptive physical exercise program on postural balance in speed skaters from 11 to 15 years compared to conventional training.

MATERIALS AND METHODS

DESIGN

Under the empirical-analytical approach, a longitudinal quasi-experimental range term was conducted. Fieldwork was carried out between May and October 2019. The research was approved by the Bioethics Committee of the Universidad Autónoma de Manizales (minutes 0083 February 13, 2019) and follows guidelines on scientific research in human beings of the Colombian Ministry of Health (resolution 8430 of 1993), and the Helsinski Declaration of the World Medical Association.

SAMPLE AND SAMPLING

Three skating clubs from the city of Manizales (Colombia) were selected. They were randomized, two clubs were the control groups, and one was the experimental group. The sample size was calculated by the formula of means comparison with a statistical power of 80% and a 95% confidence level, using the estimators proposed by Gómez-Sánchez (2013), for a minimum sample of 27 skaters in each group. All skaters into each club met the inclusion and exclusion criteria. Figure 1 presents the club sampling flowchart, recruitment, assignment, monitoring and analysis of participants.

PARTICIPANTS

Speed skaters of both genders aged between 11 and 15 years who met inclusion and exclusion criteria, signed the informed assent form, and their parents accepted their participation by signing the informed consent form too. The skaters trained more than one day weekly with sessions lasting more than an hour. Skaters with acute injuries and other health conditions that interfere with doing sports and training were excluded.

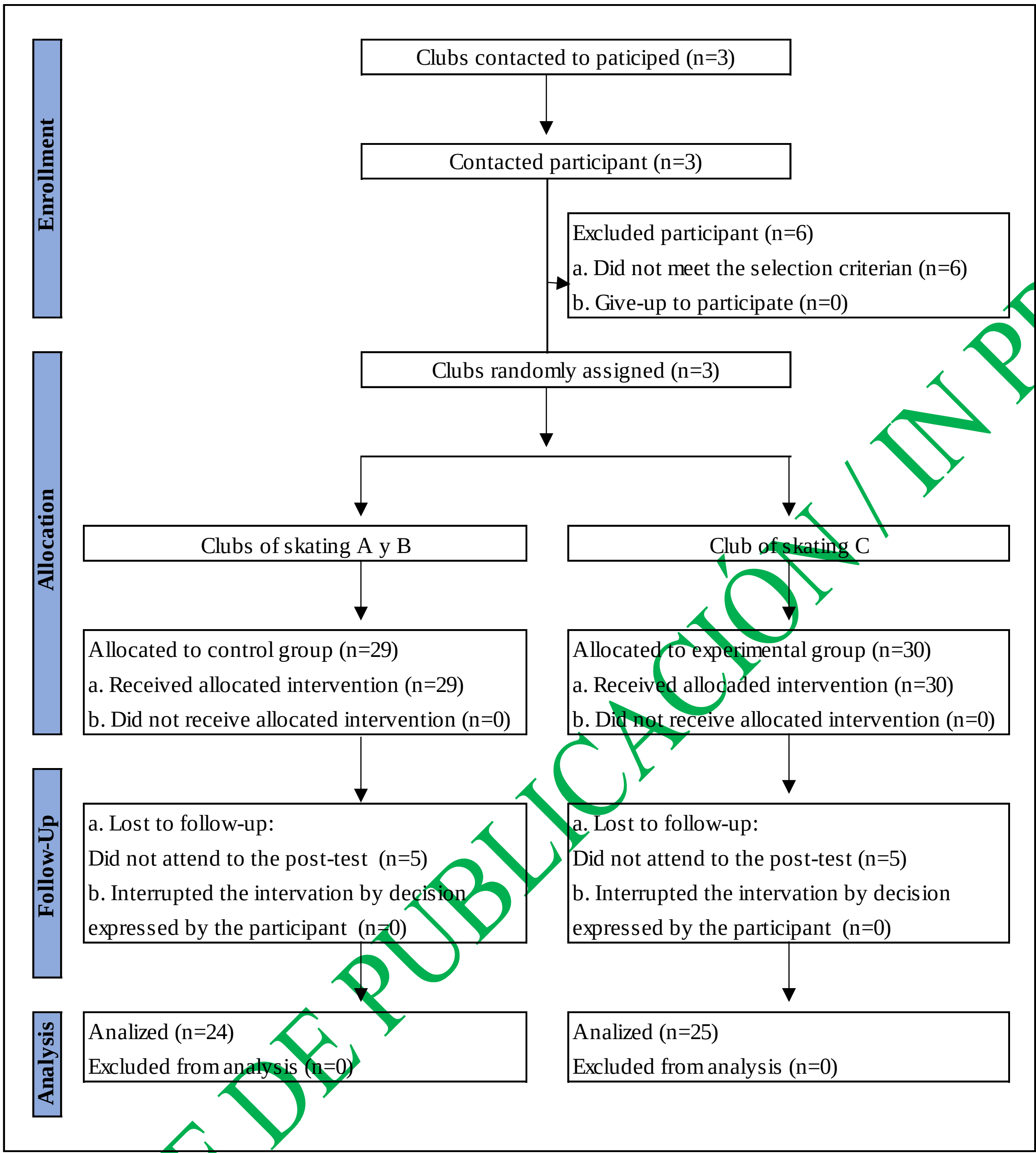

Figure 1. Sampling flowchart and participants

INTERVENTION

The research was conducted over a period of 17 weeks, the first and last week were dedicated to the assessment of participants, the other weeks were used for the implementation of the intervention programs. In both control and experimental groups, participants received three weekly 30-minute sessions, except in three weeks with fewer sessions due to weather conditions. It started with simple and comprehensive exercises, and from the fifth week progressively increased the intensity to become more specific to the sporting gesture.

The experimental group was given the proprioceptive exercise program for speed skaters proposed by Pinzón-Romero, Vidarte-Claros y Sánchez-Delgado (2019). In each session, a 10-minute warm-up was performed consisting of general joint mobility exercises and smooth running, followed by five minutes of specific warm-up. Next, five circuit-shaped proprioception exercises developed on eight levels were carried out: 1) The participant kept eyes open on a firm stable surface with a broad support base and bipodal support; 2) With eyes closed, the athlete continued in bipodal support on a firm surface and with a reduced support base; 3) With eyes open and unipodal support on a horizontally placed instability board; 4) Unipodal support with eyes open on a vertically placed instability board; 5) Unipodal support with eyes closed and on a horizontally placed instability board; 6) Unipodal support with eyes closed and on a vertically instability board; 7) On skates with eyes open; and 8) On the skates with their eyes closed. Levels 7 and 8 were combined with dynamic stretching exercises, using the sport gesture of arrival at goal. From the third to the eighth level, there were external obstacles, including arm movement simulating skating gestures, movement with a partner and the use of an air balloon. Dynamic stability exercises were performed with jumps to a progressive height of 5, 10 and 15 centimeters.

The control group performed a traditional warm-up consisting of joint mobility, smooth constant running, static muscle stretches and individual and paired games in different directions, avoiding obstacles, zigzagging, twisting and jumping.

INSTRUMENT AND OUTCOME MEASURES

The Stabilometric test was carried out in the Movement Analysis Laboratory of the Universidad Autónoma de Manizales with BTS technology®, using the baropodometry platform, and using "G-study", brand TS, P-Walk model. The skater takes a bipedal position on the platform without shoes, separate heels 10 centimeters, arms on sides of the body and head on Frankfort plane, looking at a fixed point for 30 seconds with the eyes open, and another 30 seconds with eyes closed. To measure the stability limits, the same position was taken with anteroposterior and half-lateral trunk displacement for 30 seconds each, with eyes open and closed. Stability limits, amplitude and frequency of oscillations and static balance (Romberg coefficient) were measured.

STATISTICAL ANALYSIS

Samples were described in their sociodemographic, anthropometric, sports and experimental variables. Inter-sample difference tests were performed in the pretest, intra-samples (related samples) and inter-samples for change measures. Parametric homogeneity tests were applied, as all variables overcame the assumption of normality ($p>0,050$), by bilateral test at a confidence level of 95% ($p\leq0,050$).

BIAS CONTROL

A random assignment was given to the control and experimental groups of the three participating sports clubs. The pretest and post-test assessment was performed by one of the researchers, by simple masking. The intervention to the experimental group was made by another researcher. Computerized equipment of stabilometric duly validated internationally was used and supported by biomedical engineer staff. All criteria for inclusion and exclusion of participants were met.

RESULTS

CHARACTERIZATION OF PARTICIPANTS AND INTER-SAMPLE DIFFERENCES IN THE PRETEST

The research was completed with 49 young skaters, 24 participants of the control group and 25 of the experimental group, between 11 and 15 years (mean: 13 years), the most of them female (80%); 51% runners in the long distance modality, the rest were speed skaters, with a sports practice average of 5 months, training average of 6 days a week. Mostly with normal body mass index and an average length of their lower limbs of 80 cm. Specific features for both groups can be found in Tables 1 and 2.

Table 1. Descriptives and inter-sample difference tests for proportions in the pretest (qualitative variables)

Variable		Control (n = 24)		Experimental (n=25)		Chi^2	Sig.
		N	%	N	%		
Gender	Female	19	79%	20	80%	0,005	0,942
	Male	5	21%	5	20%		
Skating Type	Background skating	13	54%	12	48%	0,186	0,666
	Speed skating	11	46%	13	52%		
Weight	Low	4	17%	1	4%	3,691	0,297
	Standard	17	71%	20	80%		
	Overweight	2	8%	4	16%		
	Obesity	1	4%				

Abbreviations. Chi^2: Chi square test, Sig.: Asymptotic bilateral significance

Table 2. Descriptive and inter-sample differences for pretest means (quantitative variables)

	Variable	Control Group (n=24)				Experimental Group (n=.25)				T	Sig.
		Minimum	Maximum	Mean	SD	Minimum	Maximum	Mean	SD		
	Age (years)	11	15	12,83	1,31	11	15	12,40	1,38	-1,125	0,266
	Weight (k)	27	67	46,10	11,49	31	65	46,16	9,50	0,019	0,985
	Height (cm)	136	172	152,21	9,71	129	172	152,88	10,79	0,229	0,820
	BMI (k/m^2)	14,41	27,06	19,67	3,50	16,07	25,67	19,57	2,38	-0,109	0,914
	LRL Length (cm)	71	92	80,23	5,90	67	95	80,80	6,37	0,325	0,747
	LLL Length (cm)	70	91	79,98	5,83	67	96	80,84	6,47	0,489	0,627
	Time span in sports' training (months)	2	10	4,67	2,44	2	11	5,60	2,68	1,273	0,209
	Weekly frequency of sports' training (days)	3	7	5,00	1,20	4	7	6,00	0,66	5,340	0,000
	Number of hours per training session	2	3	3,00	0,28	3	3	3,00	0,00	1,476	0,146
Eyes Open AP	Minimum (mm)	-96,20	-33,70	-60,16	14,40	-90,60	-27,40	-56,74	15,50	0,799	0,428
	Maximum (mm)	41,60	101,0	67,15	15,89	42,00	93,60	65,05	14,19	-0,488	0,628
	Amplitude balance	21,25	83,31	48,09	15,21	21,60	74,13	43,62	14,27	-1,061	0,294
	Oscillations (No)	16,00	34,00	25,00	4,72	13,00	40,00	25,00	7,53	0,300	0,765
	Frequency balance (Hertz)	0,53	1,13	0,82	0,16	0,43	1,33	0,83	0,25	0,300	0,765
Eyes Open ML	Minimum (mm)	-92,90	-13,20	-61,23	18,45	-106,50	-8,00	-58,88	22,55	0,399	0,692
	Maximum (mm)	10,90	86,90	53,58	17,30	13,60	81,80	54,58	16,39	0,208	0,836
	Amplitude balance	7,69	69,95	42,49	14,86	5,12	78,38	42,12	17,55	-0,079	0,937
	Oscillations (No)	13,00	40,00	24,00	6,71	17,00	56,00	27,00	8,89	1,199	0,236
	Frequency balance (Hertz)	0,43	1,33	0,81	0,22	0,57	1,87	0,90	0,30	1,199	0,236
Eyes Closed AP	Minimum (mm)	-86,90	-33,20	-59,31	15,24	-93,80	-18,20	-57,13	17,65	0,463	0,646
	Maximum (mm)	34,40	86,30	61,50	16,02	18,10	77,50	58,95	13,11	-0,611	0,544
	Amplitude balance	22,89	66,43	45,19	14,02	10,69	70,01	41,60	15,43	-0,853	0,398
	Oscillations (No)	14,00	35,00	23,00	5,11	15,00	34,00	26,00	5,75	2,191	0,033
	Frequency balance (Hertz)	0,47	1,17	0,76	0,17	0,50	1,13	0,87	0,19	2,191	0,033
Eyes Closed ML	Minimum (mm)	-89,40	-16,80	-54,10	17,91	-92,00	-9,80	-53,55	16,60	0,110	0,913
	Maximum (mm)	19,00	80,20	48,03	15,52	9,20	79,10	52,85	14,72	1,117	0,269
	Amplitude balance	12,62	66,17	36,45	13,69	4,52	64,75	38,69	13,61	0,572	0,570
	Oscillations (No)	12,00	41,00	26,00	7,17	14,00	48,00	24,00	8,04	-0,601	0,551
	Frequency balance (Hertz)	0,40	1,37	0,86	0,24	0,47	1,60	0,81	0,27	-0,601	0,551
	Romberg (CoP-EO/CoP-EC)	0,64	1,37	1,01	0,15	0,72	1,24	1,02	0,14	0,461	0,647

Abbreviations. AP: anteroposterior; ML: medial lateral; OE: eyes open; EC: eyes closed; CoP: center of pressure; SD: standard deviation; T: Student t-test for independent samples; Sig.: Bilateral asymptotic significance; LRL: lower right limb; LLL: lower left limb

Note– The difference for the test statistic was calculated by subtracting the mean from the experimental group from the mean of the control group. Equal variances are assumed for all cases.

As depicted in these tables, the sociodemographic and anthropometric variables, as well as the majority of sports and postural balance variables showed no significant differences in pretesting, thus ensuring the homogeneity of the groups prior to intervention. However, there were significant differences, favoring the experimental group with respect to the sports training weekly frequency and the sway frequency with eyes closed in anteroposterior direction (Table 2).

RELATED SAMPLE DIFFERENCES (INTRA-SAMPLE DIFFERENCES)

Both the control group and the experimental group improved the sway frequency in both directions with open and closed eyes (p<0,050). Neither static balance or stability and sway amplitude limits showed significant differences (p>0,050) (Table 3).

Table 3. Related differences of samples (Intra-sample differences)

		Control Group (n=24)					Experimental Group (n =25)				
		Means					Means				
	Variable	Pre-test	Post-test	Variability	T	Sig.	Pre-test	Post-test	Variability	T	Sig.
EO - AP	Minimum (mm)	-60,16	-56,97	3,19	0,714	0,482	-56,74	-51,51	5,23	1,483	0,151
	Maximum (mm)	67,15	61,80	-5,35	-1,130	0,270	65,05	60,41	-4,64	-1,316	0,201
	Amplitude balance	48,09	45,83	-2,26	-0,494	0,626	43,62	40,61	-3,01	-0,930	0,362
	Oscillations (No)	24,46	33,13	8,67	4,715	0,000	25,00	33,92	8,92	4,536	0,000
	Frequency balance (Hertz)	0,82	1,10	0,29	4,715	0,000	0,83	1,13	0,30	4,536	0,000
EO - ML	Minimum (mm)	-61,23	-62,27	-1,04	-0,215	0,831	-58,88	-56,93	1,95	0,351	0,729
	Maximum (mm)	53,58	52,45	-1,13	-0,255	0,801	54,58	50,42	-4,16	-1,071	0,295
	Amplitude balance	42,49	42,68	0,19	0,047	0,963	42,12	40,60	-1,52	-0,360	0,722
	Oscillations (No)	24,33	37,71	13,38	4,016	0,001	27,04	36,08	9,04	3,615	0,001
	Frequency balance (Hertz)	0,81	1,26	0,45	4,016	0,001	0,90	1,20	0,30	3,615	0,001
EC - AP	Minimum (mm)	-59,31	-60,51	-1,20	-0,271	0,788	-57,13	-55,84	1,29	0,434	0,668
	Maximum (mm)	61,5	59,33	-2,17	-0,423	0,676	58,95	60,08	1,13	0,347	0,732
	Amplitude balance	45,19	44,22	-0,97	-0,222	0,826	41,6	42,87	1,27	0,467	0,645
	Oscillations (No)	22,71	32,29	9,58	4,724	0,000	26,12	33,00	6,88	3,152	0,004
	Frequency balance (Hertz)	0,76	1,08	0,32	4,724	0,000	0,87	1,10	0,23	3,152	0,004
EC - ML	Minimum (mm)	-54,1	-56,71	-2,61	-0,498	0,623	-53,55	-53,65	-0,10	-0,022	0,983
	Maximum (mm)	48,03	47,92	-0,11	-0,026	0,979	52,85	46,64	-6,21	-1,790	0,086
	Amplitude balance	36,45	37,09	0,64	0,163	0,872	38,69	36,83	-1,86	-0,605	0,551
	Oscillations (No)	25,71	32,83	7,12	2,856	0,009	24,4	35,88	11,48	4,260	0,000
	Frequency balance (Hertz)	0,86	1,09	0,24	2,856	0,009	0,81	1,20	0,38	4,260	0,000
Romberg. (CoP-EO/CoP-EC)		1,01	1,03	0,02	0,622	0,540	1,02	1,01	-0,01	-0,219	0,829

Abbreviations. AP: anteroposterior; ML: medial lateral; EO: eyes open; EC: closed eyes; CoP: center of pressure; T: Student t-test for related samples; Sig.: Bilateral asymptotic significance
Note: differences were calculated by subtracting the post-test mean from the pretest mean

INDEPENDENT SAMPLE DIFFERENCES FOR MEASURES OF CHANGE (POST-TEST VS PRETEST)

No significant differences of measures of change were found between the control and experimental groups for any of the studied variables (p>0,050) (Table 4). This evidences that both groups, the one in conventional training and the one in the proprioceptive exercise training program, improved the sway frequency without significant differences. Stability limits and sway amplitude did not improve with any of the exercise training programs.

Table 4. Inter-sample differences for measures of change (Post-test vs pre-test)

	Variable	Means			t-Student	Bilateral significance
		Control	Experimental	Difference		
EO - AP	Minimum (mm)	3,20	5,24	2,04	0,359	0,721
	Maximum (mm)	-5,34	-4,64	0,71	0,120	0,905
	Amplitude balance	-2,26	-3,01	-0,75	-0,134	0,894
	Oscillations (No)	8,67	8,92	0,25	0,094	0,926
	Frequency balance (Hertz)	0,29	0,30	0,01	0,094	0,926
EO - ML	Minimum (mm)	-1,04	1,95	2,99	0,404	0,688
	Maximum (mm)	-1,13	-4,16	-3,03	-0,514	0,610
	Amplitude balance (mm)	0,19	-1,51	-1,71	-0,289	0,774
	Oscillations (No)	13,38	9,04	-4,34	-1,047	0,301
	Frequency balance (Hertz)	0,45	0,30	-0,14	-1,047	0,301
EC - AP	Minimum (mm)	-1,20	1,29	2,49	0,472	0,639
	Maximum (mm)	-2,17	1,14	3,30	0,548	0,586
	Amplitude balance (mm)	-0,97	1,28	2,25	0,439	0,662
	Oscillations (No)	9,58	6,88	-2,70	-0,905	0,370
	Frequency balance (Hertz)	0,32	0,23	-0,09	-0,905	0,370
EC - ML	Minimum (mm)	-2,61	-0,10	2,51	0,363	0,718
	Maximum (mm)	-0,10	-6,21	-6,11	-1,159	0,252
	Amplitude balance (mm)	0,64	-1,85	-2,49	-0,503	0,617
	Oscillations (No)	7,13	11,48	4,36	1,183	0,243
	Frequency balance (Hertz)	0,24	0,38	0,15	1,183	0,243
Romberg. (CoP-OE/CoP-EC)		0,03	-0,01	-0,04	-0,546	0,588

Abbreviations. AP: anteroposterior; ML: medial lateral; EO: eyes open; EC: closed eyes; CoP: center of pressure

Note: The group means were calculated by the difference between the post-test and the pretest. The difference was calculated by subtracting the mean from the experimental group to the mean of the control group. Equal variances are assumed for all cases.

DISCUSSION

Both groups, the one in conventional training and the one in proprioceptive exercise training program, improved the sway frequency (post-test vs pre-test) without significant differences between them regarding the measures of change. Stability limits and sway amplitude did not improve with any of the training programs.

In contrast, Pinzón-Romero, Vidarte-Claros and Sánchez-Delgado (2019) found significant differences in dynamic balance in the posterior left and posterior left medial directions, while in static balance no significant differences were found with respect to the control group in conventional training. The cited authors evaluated the effect of a proprioceptive physical exercise program on balance in young skaters, using the SEBT (*Start Excursion Balance Test*) for dynamic balance and the BESS (*Balance Error Scoring System*) for static postural stability. In our study, both dynamic and static balance were evaluated with stabilometry tests in a laboratory for movement analysis with a baropodometry platform and following the Belaguer (2013) protocol. This may explain the contradictory results of both studies.

Knowing the situation of static and dynamic balance aids in the planning and designing an appropriate intervention according to the athletes' psychomotor and functional conditions and their postural control as well (Villalobos-Samaniego, Rivera-Sosa, Ramos-Jiménez, Cervantes-Borunda, López-Alonzo and Hernández-Torres, 2019).

In this study we used stability tests where the skaters shifted their center of gravity towards the borders of these limits without modifying their support base, as proposed by Peydro, Baydal and Vivas (2005). Hrysomallis (2011) highlights the usefulness and validity of force platforms to record the displacements of the center of pressure, considered as the origin of all vertical forces transmitted through the base of the system.

Skating as a physical activity involves introducing different conditions of displacement, that is, it leads to continuous balance changes with a reduced base of support. There are changes of speed, in the start considering the axis of gravity, in the space during the trajectory of displacement and in the extremities, both in the upper body (balancing arms and head working as a movement guide) and in the lower body (the legs as the main motor of movement that allow maintaining the trajectory). In this sense, the proprioceptive sensations of athletes are intensified, since they must be conscious and keep the balance of their body movements at all times (Lamoth and Van Heuvelen, 2012).

The center of gravity, inside or outside its base of support, determines the degree of balance that the skaters have according to their sporting gesture. These cause different functional modifications in postural balance to overcome gravity and rearrange their center of gravity to the demands of the sport, and in turn rapid muscle contraction around the joints. The above allows skaters to accelerate and maintain postural balance avoiding falls or muscle fatigue, and injury and relapse decrease (González, Oyarzo, Fischer, De la Fuente, Diaz, and Berral, 2011; Brachman, Kamieniarz, Michalska, Pawlowski, Slomka, and Juras (2017) propose a relationship between proprioceptive training and physical performance, postural control, and injury prevention.

In our study, no significant changes were found in the sway amplitude neither in the control group or the experimental group. In this regard, Verbecque, Vereeck and Hallemans (2016) conclude that as age increases, swing speed tends to decrease in a bipedal position with eyes open, especially after 12 years. At this age, similar responses to those of adults can be achieved. Likewise, with eyes closed, the oscillation speed, the area and range of amplitude decrease significantly with age raise (Newell, Slobounov, Slobounova and Molenaar, 1997; Rival, Ceyte and Olivier, 2005). This finding is noteworthy because it is assumed that postural stability is reflected in a small area of postural sway in the rest position and in the ability to bring the center of pressure closer to the edge of the support surface (Rival, Ceyte & Oliver, 2005).

Despite the supposed benefits of a proprioceptive exercise program towards young skaters, the evaluation of the balance in static position did not show significant differences in the measures of change, this may be due to the measurement characteristics as suggested by Verbecque, Vereeck and Hallemans (2016). They state that a digitized stabilometry test is sensitive to any change, either in the position of the feet or arms. A visual target can have a large impact on the amount of sway and this can directly influence measurements and stability limits, which may partially explain the results of this study.

Likewise, Winter, Beck, Walther, Zwipp and Rein (2015) found that no significant improvement in static balance was not achieved after 6 to 12 weeks with proprioceptive training in speed skaters, while dynamic balance indeed showed changes especially in the anterior-posterior and medial-lateral stability of the ankle. Other authors consider that static evaluation tests for skaters are inappropriate because it is not a challenge for those who are compete (Hinman, 2000; McKeon and Hertel, 2008)

CONCLUSIONS

Both groups in conventional training and the one in proprioceptive exercise program improved the swing frequency (post-test vs pre-test) without exhibiting significant differences between them regarding the measures of change. Stability limits and sway amplitude did not improve with any of the training programs.

It is recommended that future studies perform random assignment of subjects to groups, thus avoiding assignment by clubs. Likewise, including both functional and laboratory tests, in order to compare them and thus rule out the possible effect of the complexity of the stabilometric test on the results.

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