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Physical complaints and participation habits in female artistic roller skaters
Quejas físicas y hábitos de participación en patinadoras artísticas femeninas

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Abstract. Introduction: Educational and health professionals need to acquire knowledge about the specific needs of figure skaters, aiming at their effectiveness in training and preventing physical complaints (PC) or injuries. Thus, it is essential not only to characterize the participants and participation habits but also to understand how associations between the characterization and the practitioners' participation habits can influence the frequency of PC or injuries. Objective: To associate the different participation habits and frequency of PC in female figure skaters in the last 12 months. Methods: A web-based survey was developed to gather epidemiological details on female artistic roller skaters. The self-response questionnaire covered participant details, participation habits, injury history, and PC within the last 12 months. Participants were invited through official and informal communication channels devoted to artistic roller skating. Results: This study included 143 female artistic roller skaters. Sixty-seven (46.9%) participants experienced 175 episodes (injuries or PC) within the last 12 months, an average of 2.61 complaints per skater. Significant relationships between chronic health conditions (CHC) with category and level of tournaments were found. A higher percentage of skaters with CHC (77.8%) participated in national-level tournaments. Older athletes with previous injuries were at greater risk of injury. A significant relationship was found between previous injuries and PC. Conclusions: Our findings suggest that artistic roller-skating PC are frequent. Changing coaches throughout the athlete's career, increasing the number and hours of training per week, and changing equipment such as boots, or chassis are more likely to have PC.
Keywords: artistic roller skating; injuries frequency; participation rates; physical complaints; web-based questionnaire.

Resumen. Introducción: Los profesionales de la educación y de la salud necesitan adquirir conocimientos sobre las necesidades específicas de los patinadores artísticos, visando su efectividad en el entrenamiento y prevención de molestias físicas (PC) o lesiones. Por lo tanto, es esencial no solo caracterizar a los participantes y los hábitos de participación, sino también comprender cómo las asociaciones entre la caracterización y los hábitos de participación de los profesionales pueden influir en la frecuencia de PC o lesiones. Objetivo: Asociar los diferentes hábitos de participación y frecuencia de PC en patinadoras artísticas femeninas en los últimos 12 meses. Método: Se desarrolló una encuesta basada en la web para recopilar detalles epidemiológicos sobre patinadoras artísticas femeninas. El cuestionario de autorrespuesta cubrió los detalles de los participantes, los hábitos de participación, el historial de lesiones y el PC en los últimos 12 meses. Los participantes fueron invitados a través de canales de comunicación oficiales e informales dedicados al patinaje artístico sobre ruedas. Resultados: Este estudio incluyó a 143 mujeres patinadoras artísticas. Sesenta y siete (46,9%) participantes experimentaron 175 episodios (lesiones o PC) en los últimos 12 meses, un promedio de 2,61 quejas por patinador. Se encontraron relaciones significativas entre las condiciones de salud crónicas (CHC) con la categoría y el nivel de los torneos. Un mayor porcentaje de patinadores con CHC (77,8%) participó en torneos a nivel nacional. Los atletas mayores con lesiones previas tenían un mayor riesgo de lesionarse. Se encontró una relación significativa entre lesiones previas y PC. Conclusiones: Nuestros hallazgos sugieren que los PC artísticos de patinaje sobre ruedas son frecuentes. Cambiar de entrenador a lo largo de la carrera del deportista, aumentar el número y las horas de entrenamiento a la semana, y cambiar de equipamiento como botas o chasis es más probable que tenga PC.
Palabras clave: patinaje artístico sobre ruedas; frecuencia de lesiones; tasas de participación; dolencias físicas; cuestionario basado en la web.

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Introduction

Artistic roller-skating is a sport in which a movement on a sliding surface is implied, the essential feature of which is the use of skates. Depending on the skates' surface, the skates have different characteristics, allowing variations in the modality (Lagoa, 2009). This modality combines music, gestures, and expressiveness, as well as the mastery of technical elements and their integration in the choreography, requiring a perfect mastery of the body with continuous and persistent work (FPP, 2019).

Regarding the number of practitioners, Portugal has 15,431 filiated skaters, including not only Figure Skating, but also Roller Hockey, Speed Skating, and Skate (Pordata, 2021). With the number of practitioners increasing since 2010, figure skating has increasingly become a sport of high competition, demanding high performance from athletes, and including rigorous and intense training, which can lead to an increased risk of injury (Porter et al., 2007). An injury can often produce an absence of sports practice, permanent disability, chronicity, impact on performance, variations in the duration of treatments, and reduced quality of life (Andrew et al., 2010; Cumps et al., 2008). Therefore, the etiology and risk factors associated with sports injuries are a major concern for professionals in sports medicine teams (Brooks & Fuller, 2006; Kolt, 2013). Consequently, preventing injuries should be considered a crucial aspect (Best & Shrier, 2007; Chalmers, 2002). In this field, epidemiological investigation should be regarded as the first step forward (van Mechelen et al., 1992). In researching the etiology of sports in-juries, as well as in the implementation of effective preventive measures, we will not only be able to reduce the number of occurrences but also events related to recurrences, the

duration of the injury impact, and the underlying economic burden (Brooks & Fuller, 2006; van Mechelen et al., 1992). Over the past few decades, some researchers have dedicated themselves to capturing and analyzing evidence from epidemiological studies, which has helped them to find patterns of injuries and their etiology in different sports activities (Hrysomallis & Morrison, 1997). However, due to the complexity of the methodological aspects of epidemiological research, the best methods for capturing data on sports injuries are constantly evolving. This evolution ensures that the resources and time spent on epidemiological research are fair, clearly identifying the variables under study (Kolt, 2010, 2011).

Skating, in addition to improving athletes' health through exercise, also exposes children to a risk of injury (Knox et al., 2006). Therefore, sports type is of considerable importance in understanding the risk of injury. The sports with the highest number of injuries feature a high-speed or explosive technical gesture. In sports, the most injured areas of the body are the ankle and knee, followed by the hand, elbow, wrist, leg, head, neck, and collarbone (Adirim & Cheng, 2003). Adolescents are more vulnerable to sports injuries because they participate earlier and more intensely in sports and in rapid growth and neurobiological maturation in an increasingly competitive and selective psychosocial environment. The pattern of injury occurrence (types, causes, and distribution) in young adolescents is like that in adult professional athletes. In the young athlete who is still in the process of growth/development (particularly fast in the pubertal leap period or "spurt period"), the growth cartilages at the ends of the long bones (epiphyses) are particularly vulnerable to mechanical overload injuries (compression forces) (Oliveira, 2007).

Another characteristic of these ages (10-16/17 years) that constitutes a vulnerable point that is related to the different rhythms of accelerated growth between the bones, muscles, and ligaments. The peak of bone growth is out of phase with (before) the peak of soft tissue growth. This fact increases the susceptibility to injury at the bone attachment sites of tendons and ligaments. On the other hand, the growth and neurobiological maturation rhythms are individual and determined by the interaction between genetic and environmental factors (Oliveira, 2007). As the division by age groups in all sports is done exclusively by chronological age, two young people with the same chronological age may have different maturation profiles. This maturation gap between opponents, particularly in contact sports and sports where muscle strength is essential, may constitute an increased risk of injury for young people with a less developed maturational stage (Jorna & Elferink-Gemser, 2016).

Replacing leadership outside its natural periods is undoubtedly one of the most important decisions an organization can face. This replacement should occur recurrently so the change process can have the best possible planning. However, changing the leadership in the middle of the cycle may have negative consequences once it seems to be a negative correlation between the number of coach changes and the average classification of each team (Silvestre, 2011). In the different modalities, it is common for the practitioners to change coaches, as in Skating.

The risk of injury is always going to be inevitably attached to any sporting activity due to its nature, but we can reduce it if we achieve greater knowledge about this and how to carry out an effective preventive work. Despite the fact that the injuries have a multifactorial origin, there are some known risk factors, which can be specific to an activity to be carried out (Muñoz et al., 2023).

The exposure time may also constitute a risk factor for injury. Young people with aspirations to compete internationally exponentially increase the time of exposure to risk before major events. In addition, the non-gradual increase in training time and intensity creates additional risks for injury in the young athlete during the maturation phase. Consequently, the activity planning process must incorporate forms of effort recovery, adequate nutritional intakes, alternation of training of the different components of the activity, and recognition of indicators that tell us that the physiological and psychological limits are being tested (Oliveira, 2007).

In the same line, the maintenance of the material is fundamental for the quality/technical performance of the athlete. The boots are usually replaced every 6 to 12 months, depending on the conservation and maintenance that the skater applies to them, to avoid their deterioration (Porter et al., 2007), which makes the change of material throughout the crucial years, such as its cleaning. Therefore, when a sports shoe is not suited to an individual's specific needs, it can cause movement patterns that overload the human locomotor structure, resulting in chronic pain and injuries (Wang et al., 2020). Furthermore, as a high-performance sport, skating requires hours of daily training and practicing with an uncomfortable skate, which can cause injuries to the athlete's feet and impair their performance.

To our knowledge, there has been a total absence of epidemiological studies elucidating the extent of PC or injuries that may affect Portuguese skaters. This gap compromises the accurate assessment of PC in skaters and the further development of effective prevention programs. Therefore, the present study aimed to evaluate possible associations between participation habits and PC in a sample of Portuguese female skaters within the last 12 months. The hypotheses that we will test throughout the study are: 1) which part of the body is most affected; 2) how participation habits such as the number of times you train influence the number of PC; 3) how the level of competition influences the number of PC; 4) how the material influences the PC number.

Materials and Methods

A cross-sectional retrospective study was conducted to

collect self-reported data using a web-based questionnaire in the Portuguese language. Data were collected between August and December 2018 by recruiting artistic roller skaters' members of the Federação Portuguesa de Patinagem (FPP).

A total of 1840 artistic roller-skating participants registered with FPP and their national association were invited to participate in the web-based survey. From these, 368 have responded (346 women and 22 men). Due to incomplete responses, 212 were excluded. Of the remaining sample of 156 participants, 13 men were excluded based on the study objective. This way, 143 complete responses were obtained from female artistic roller-skating participants. Although a substantial proportion (82.5%) were minors, more than half (58.7%) completed the questionnaire without assistance, while the remainder sought help from their parents or guardians. When monitoring each participant's IP address and email, no duplicate responses were detected. The web-based survey took an average of eight minutes to complete.

All 143 skaters were divided into two groups. About 124 (86.7%) children and adolescents who were under 20 years of age were included in the first group (G1), and the remaining 19 (13.3%) over 20 years old were included in the second group (G2).

Sampling frame

The web-based questionnaire was distributed in early June 2018 through official and informal communication channels. The research team asked the FPP for permission and access to the members of their mailing list. Access to a web link was institutionally distributed by FPP and Associação de Patinagem de Setúbal to all affiliated clubs and associations. In addition, the link was shared on social media during the National Free Skating Championship held in Faro in July 2018. The dissemination strategy included detailed information about the study and data handling, and confidentiality.

Normative data were collected from the FPP online platform to ensure that our study sample differed significantly from the Portuguese artistic roller-skating community (FPP, 2019). Therefore, no additional restrictions were imposed to ensure representativeness.

Data were collected from 143 women (92.3%) and 13 men (7.7%). Although the gender distribution of the Portuguese artistic roller-skating population is representative, the final sample included only females due to the aim of our study. We divided the roller skaters into two groups. About 124 (86.7%) children and adolescents under 20 years of age were included in the first group (G1), while 19 (13.3%) young adults over 20 years of age formed the second group (G2).

For the correct analysis of the stature and weight percentiles of the participants, we used the curves of the National Center for Health and Statistics (NCHS) (DGS, 2006).

Web-based questionnaire

The web-based questionnaire allowed information on participation habits and PC about figure skating in the last 12 months. This instrument was made available on the Limesurvey servers (Lime Survey, 2013).

Definition of outcomes

Well-established definitions of 'chronic health conditions', 'previous injuries', and 'physical complaints' were required for some outcomes. A chronic health conditions (CHC) was defined as "a heart condition, respiratory disease, osteoarthritis, or the like that might limit the practice of artistic roller skating." A previous injury (PI) was defined as "an injury related to participation in artistic roller-skating that occurred in the last 12 months ago." Physical Complaints (PC) related to artistic roller-skating participation were defined as "a simple complaint such as complaints or more disturbing symptoms such as pain or complaints, regardless of the need for medical treatment, effect on performance, or absence from artistic roller-skating participation."

Ethical Considerations

Ethical approval for this study was obtained from the Ethics Committee of the Universidade de Évora (CEICASHBE/UE/18032). Although identifying parameters were recorded, they were used only to exclude duplicate responses. After this procedure, each participant was given a code that precluded further identification at any study stage, thus ensuring complete anonymity. A written informed consent form was also signed by each participant for their participation in this study. For those younger than 18 years of age, the consent form was signed by their legal guardian, who assisted in completing the questionnaire and understanding it.

Statistical analysis

Responses to the questionnaire were summarized in the web-based data set and exported to a syntax/data file. The files were then imported into IBM® SPSS® Statistics version 26 (IBM Corp. Released 2019. Armonk, NY), providing descriptive and inferential statistics. An alpha significance level of 5% was used for the inferential statistics, except for some correlations (1%). Statistical p-values below these references were considered significant, rejecting the null hypothesis.

The univariate analysis focused on summarizing and describing the results of each question. For categorical variables, we counted frequencies of responses using percentages. For continuous questions, we used measures of central tendency (mean, median) and dispersion (standard deviation, range).

Bivariate analysis was conducted using cross-tabulations to examine the association between categorical questions (Chi-square, Phi, and Cramer V), comparison of means for categorical and continuous questions (Mann-Whitney U-test, Kruskal Wallis, T-test, or ANOVA), and

the tendency for two continuous questions (Spearman's Rho and Pearson).

Results

Participant details

The general descriptive elements of the sample are presented in Figure 1. Categorizing 124 G1 women by percentiles, we found that 103 (83.1%) had normal stature, 14 (11.3%) were tall, and 7 (5.6%) were short. We also found that two skaters were moderately malnourished. After classifying weight status into percentiles in 124 G1 women, we found that 105 skaters (84.7%) were at a healthy weight, 14 (11.3%) were overweight, 3 (2.4%) were underweight, and 2 (1.6%) were obese.

		n	Mean	SD	Median	Mode	Min	Max
Age (years)								
	Overall	143	14.0	4.4	14.0	14.0	6.0	26.0
	G1 (< 20 yr.)	124	12.8	3.3	13.0	14.0	6.0	19.0
	G2 (≥ 20 yr.)	19	22.0	1.9	21.0	21.0	20.0	26.0
Height (cm)								
	Overall	143	153.2	14.0	158.0	160.0	112.0	176.0
	G1 (< 20 yr.)	124	151.5	14.1	156.5	160.0	112.0	176.0
	G2 (≥ 20 yr.)	19	164.3	5.2	166.0	164.0	150.0	170.0
Weight (kg)								
	Overall	143	47.0	13.4	50.0	50.0	19.0	80.0
	G1 (< 20 yr.)	124	44.4	12.0	49.0	50.0	19.0	75.0
	G2 (≥ 20 yr.)	19	64.2	8.9	65.0	50.0	50.0	80.0
Body Mass Index (kg/m²)								
	Overall	143	19.6	3.2	19.5	19.1	13.2	29.0
	G1 (< 20 yr.)	124	19.0	2.8	19.1	19.1	13.2	26.0
	G2 (≥ 20 yr.)	19	23.7	2.6	23.8	26.3	19.5	29.0

Figure 1. Participant´s details.

Health results

Physical complaints

Sixty-seven (46.9%) skaters had PC in the past 12 months. Their mean age was 14.24 years (7 to 24 years). The anatomical distribution of 175 PC per 67 skaters is summarized in Figure 5. PC were most reported in the lower limbs (53.1%), followed by head and boot (24.0%) and upper limbs (22.9%). Regarding the most affected regions, it was the knees with 16.7%, followed by the ankles with 9.7%. In the trunk, it was the back with 10.9%, and in the upper limbs, it was the wrists with 10.3%.

When looking at 143 skaters on the status of PC during the past 12 months per category, we found that only three categories (Tot, Cadet, and Junior) had more skaters reporting complaints (Figure 2). The numerical difference between the absence and presence of PC was found in the cadet category (n=4).

As mentioned earlier, there were 67 skaters with a total of 175 PC, an average of 2.61 complaints per person. When broken down by category, the highest rate was found in the adolescent category (4.0 PC). The lowest rate was found in the minis (1.86 PC). Except for the former category, the average rate for each level was over 2.0 complaints per skater. The separate PC rates for each level of play are shown in Figure 2.

Of the 67 skaters who reported PC, 67.2% described multiple episodes. The highest number of multiple episodes (n=10) was found in a 21-year-old (senior) female skater.

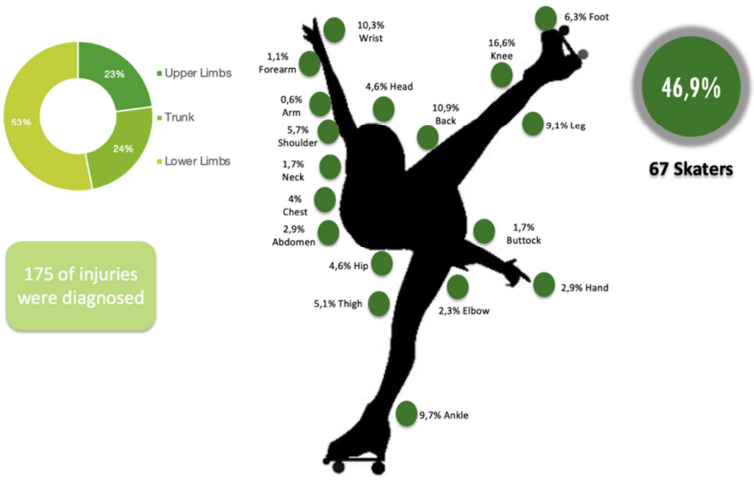

Figure 2. Distribution of physical complaints per anatomical distribution.

Associations between Health Outcomes

Chronic Health Conditions

A significant relationship was found between the category and the presence of CHC (χ^2 (7) =14.9 and p=.038). Those participating in a cadet age group (14 and 15 yr.) showed the highest prevalence (58.3%). Chronic conditions were absent in initiation (3 to 7 yr.), minis (10 and 11 yr.), espoir (12 and 13 yr.), and youth (16 yr.). We also found a significant relationship between the level of tournaments and the presence of CHC (χ^2 (7) =16.5 and p<.0001). A higher percentage of skaters with CHC (77.8%) participated in national-level tournaments. The district and international tournaments revealed residual percentages (11.1% each).

Previous Injuries

A significant relationship was found between previous injuries and PC (χ^2 (1) =23.6, p<.001). Total concurrence was found at the back (n=12), thigh (n=2), shoulder (n=1), thigh (n=2), and head (n=1). Half of the PC at the knees (n=7) and wrist (n=2) were also found at concurrent locations.

The risk estimates and analysis of the association between age group and status of previous injuries were computed. Those over 20 years of age were 4.0 times more likely to report a previous injury as compared to those under 20 years of age (OR=4.0, CI=1.4 – 11.3).

Physical Complaints

No significant differences were found between the mean age for those with or without reporting PC ($\bar{x}$= 14.2 yr. vs. $\bar{x}$= 13.8 yr., U=2332.5, p=.386).

Associations with Health Outcomes

We searched for the association between several variables and health outcomes. A summary of descriptive and statistical results is depicted on tables 1, 2 and 3.

Table 1.
The association between the variables category, discipline, coach, number of coaches and health outcomes.

Variables	Chronic Conditions			Previous Injuries			Physical Complaints		
	Absent n (%)	Present n (%)	P value	Absent n (%)	Present n (%)	P value	Absent n (%)	Present n (%)	P value
Category									
Initiation	5 (3.8)	-		5 (4.3)	-		4 (5.3)	1 (1.5)	
Tot	20 (15.3)	1 (8.3)		18 (15.5)	3 (11.1)		10 (13.2)	11 (16.4)	
Minis	20 (15.3)	-		20 (17.2)	-		13 (17.1)	7 (10.4)	
Espoir	21 (16.0)	-	.038*	20 (17.2)	1 (3.7)	.005*	13 (17.1)	8 (11.9)	.667
Cadet	23 (17.6)	7 (58.3)		20 (17.2)	10 (37.0)		13 (17.1)	17 (25.4)	
Youth	8 (6.1)	-		7 (6.0)	1 (3.7)		4 (5.3)	4 (6.0)	
Junior	11 (8.4)	2 (16.7)		11 (9.5)	2 (7.4)		6 (7.9)	7 (10.4)	
Senior	23 (17.6)	2 (16.7)		15 (12.9)	10 (37.0)		13 (17.1)	12 (17.9)	
Discipline									
Free	99 (75.6)	9 (75.0)		91 (78.4)	17 (63.0)		56 (73.7)	52 (77.6)	
Figures	3 (2.3)	1 (8.3)		4 (3.4)	-		3 (3.9)	1 (1.5)	
Solo Dance	8 (6.1)	2 (16.7)	.276	7 (6.0)	3 (11.1)	.195	6 (7.9)	4 (6.0)	.880
Show and Precision	5 (3.8)	-		4 (3.4)	1 (3.7)		3 (3.9)	2 (3.0)	
Mixed	16 (12.2)	-		10 (8.6)	6 (22.2)		8 (10.5)	8 (11.9)	
Coach									
No	11 (8.4)	3 (25.0)	.064	9 (7.8)	5 (18.5)	.090	4 (5.3)	10 (14.9)	.052
Yes	120 (91.6)	9 (75.0)		107 (92.2)	22 (81.5)		72 (94.7)	57 (85.1)	
Number of Coach									
1	43 (32.8)	2 (16.7)		40 (34.5)	5 (18.5)		29 (38.2)	16 (23.9)	
2	28 (21.4)	3 (25.0)	.685	26 (22.4)	5 (18.5)	.159	21 (27.6)	10 (14.9)	.013*
3	21 (16.0)	2 (16.7)		19 (16.4)	4 (14.8)		8 (10.5)	15 (22.4)	
4 or more	39 (29.8)	5 (41.7)		31 (26.7)	13 (48.1)		18 (23.7)	26 (38.8)	

Table 2.
The association between the variables training surface, tournament participation, regular training (week), competition training (week) and health outcomes.

Variables	Chronic Conditions			Previous Injuries			Physical Complaints		
	Absent n (%)	Present n (%)	P value	Absent n (%)	Present n (%)	P value	Absent n (%)	Present n (%)	P value
Training Surface									
Cement	18 (13.7)	-		11 (9.5)	7 (25.9)		6 (7.9)	12 (17.9)	
Wood	104 (79.4)	11 (91.7)	.389	97 (83.6)	18 (66.7)	.064	65 (85.5)	50 (74.6)	.182
Synthetic	9 (6.9)	1 (8.3)		8 (6.9)	2 (7.4)		5 (6.6)	5 (7.5)	
Tournament Participation									
No	26 (19.8)	105 (80.2)	.671	26 (22.4)	90 (77.6)	.188	20 (26.3)	56 (73.7)	.056
Yes	3 (25.0)	9 (75.0)		3 (11.1)	24 (88.9)		9 (13.4)	58 (86.6)	
Regular Training (week)									
Under 2 hours	15 (11.5)	3 (25.0)		15 (12.9)	3 (11.1)		13 (17.1)	5 (7.5)	
Between 2 to 5 hours	57 (43.5)	1 (8.3)	.089	49 (42.2)	9 (33.3)	.425	35 (46.1)	23 (34.3)	.011*
Between 5 to 10 hours	55 (42.0)	7 (58.3)		47 (40.5)	15 (55.6)		28 (36.8)	34 (50.7)	
More than 10 hours	4 (3.1)	1 (8.3)		5 (4.3)	-		-	5 (7.5)	
Competition Training (week)									
Between 2 to 5 hours	37 (35.2)	1 (11.1)		35 (38.9)	3 (12.5)		23 (41.1)	15 (25.9)	
Between 5 to 10 hours	47 (44.8)	5 (55.6)	.460	40 (44.4)	12 (50.0)	.031*	27 (48.2)	25 (43.1)	.046*
Between 10 to 20 hours	20 (19.0)	3 (33.3)		14 (15.6)	9 (37.5)		6 (10.7)	17 (29.3)	
More than 20 hours	1 (1.0)	-		1 (1.1)	-		-	1 (1.7)	

Table 1 shows an association in the category variable with chronic conditions and previous injuries. It was the cadets (58,3%) who had the most chronic conditions, and it was the cadets (37,0%) and seniors (37,7%) who had the most previous injuries. If chronic conditions already exist, what can be related, is prone to more previous injuries.

The number of coaches is also significantly associated with PC, so those who had four or more coaches (38,8%) are more likely to have PC.

Regarding table 2, the number of workouts per week showed significant differences with PC. Those who train for five to ten hours have more PC (50,7%). When we increase the number of hours, the number of PC tends to increase, but when we exceed the ten hours this does not happen, with only 7.5% of athletes indicating this value. Training above average can also raise the precondition since the musculoskeletal system is more willing to that load. Thus, we assume that they have been practicing for over ten hours for several years. Hence there is no oscillation.

Competition training showed significant differences with previous injuries, with the highest percentage of 50.0% between five and ten hours. In addition, competition training showed significant differences with PC, with the highest percentage of 43.1% between five and ten hours.

Table 3.
The association between the variables wheels/bearings (maintenance), roller boots (replacement), roller plates (replacement) and health outcomes.

Variables	Chronic Conditions			Previous Injuries			Physical Complaints		
	Absent n (%)	Present n (%)	P value	Absent n (%)	Present n (%)	P value	Absent n (%)	Present n (%)	P value
Wheels/Bearings (maintenance)									
Every use	4 (3.1)	-		3 (2.6)	1 (3.7)		1 (1.3)	3 (4.5)	
Weekly	16 (12.2)	3 (25.0)		15 (12.9)	4 (14.8)		10 (13.2)	9 (13.4)	
Monthly	58 (44.3)	6 (50.0)	.569	54 (26.6)	10 (37.0)	.767	37 (48.7)	27 (40.3)	.516
Yearly	8 (6.1)	1 (8.3)		6 (5.2)	3 (11.1)		3 (3.9)	6 (9.0)	
When you have problems	45 (34.4)	2 (16.7)		38 (32.8)	9 (33.3)		25 (32.9)	22 (32.8)	
Roller Boots (replacement)									
Yearly	16 (12.2)	3 (25.0)		16 (13.8)	3 (11.1)		9 (11.8)	10 (14.9)	
Between 1 to 2 years	54 (41.2)	1 (8.3)	.068	49 (42.2)	6 (22.2)	.093	37 (48.7)	18 (26.9)	.027*
Between 3 to more years	61 (46.6)	8 (66.7)		51 (44.0)	18 (66.7)		30 (39.5)	39 (58.2)	
Roller Plates (replacement)									
Yearly	1 (0.8)	1 (8.3)		2 (1.7)	-		2 (2.6)	-	
Between 1 to 2 years	46 (35.1)	1 (8.3)	.023*	42 (36.2)	5 (18.5)	.149	29 (38.2)	18 (26.9)	.123
Between 3 to more years	84 (64.1)	10 (83.4)		72 (62.1)	22 (81.5)		45 (59.2)	49 (73.1)	

As shown in table 3, wheels/bearings are not significant for chronic conditions, previous injuries, and PC.

Boots have significant differences concerning PC. Those who change boots after three or more years are at greater risk (58,2%); thus, the ability of boots to stabilize the ankle is relevant.

About roller plates, there are significant differences in chronic conditions, with a greater number of those who change chassis after three or more years (83,4%).

In the continuous variables of the study concerning chronic conditions, those with more experience (more years of practice) have a greater number of chronic conditions. When we move on to previous injuries, with more than 12 months, almost all variables are significant. There is an association between age, height, weight, and experience. Regarding PC, nothing is associated with the presence or absence of PC.

Regarding the number of episodes of PC, there were significant differences in the number of coaches.

Discussion

This study aimed to evaluate possible associations between participation habits and PC related to the practice of skating during the last 12 months in Portuguese female roller-skaters.

The most common injuries in figure skating are musculoskeletal and often repetitive strain attempts. The contributing factors are skateboards, the training regimen, environmental factors, and high sports conventions competition. Regarding the anatomical location, it was the knee (579%) (Moreira, 2013). In our study of 67 skaters who reported PC, 67.2% described multiple episodes. When testing hypothesis 1 evaluating the most affected area of the body, we found that it was the lower limbs.

In our study, the back has a high percentage of PC and/or injuries, with the highest percentage being in the lower region. Low back pain can be caused by facet pain, lesions of the posterior iliac crest, and spondylosis. These injuries may be related to the stiffness of the skater's boot. Increased stiffness limits ankle and knee movement, causing the skater to increase flexion at the hip and extend the back to maintain balance (Porter et al., 2007).

The most prevalent injuries are repetitive strain injuries, such as posterior tibial tendinopathy, generalized tendonitis, patellofemoral joint dysfunction, ankle and knee injuries and leg injuries. In fact, also in our study, the lower limbs, with a particular focus on the knee and ankle, emerge as potential areas for injuries in figure skating. In addition, there is a prevalence of injuries in the lower limb that may be related to the mechanics of propulsion and jumping, as it involves an excessive eversion movement and excessive pronation in young skaters (Fortin & Roberts, 2003). Injuries to the wrist are un-common in figure

skaters, assuming themselves, fundamentally as potential PC, as seen in our study (Porter et al., 2007).

By investigating etiology of sports injuries and effective preventive measures implementation, we can reduce the number of occurrences, their recurrence, the duration of the disability, and the underlying economic burden (Brooks & Fuller, 2006; van Mechelen et al., 1992). These injuries, which can be associated with recurrent problems, acute or chronic, are common in figure skating (such as acute musculoskeletal injuries, chronic injuries from overuse, and other medical problems) (Fortin & Roberts, 2003). Overload injuries are lesions with no identifiable acute trauma; they are reportedly the most frequent type of injury in sports. These injuries are caused by repetitive microtraumas resulting from excessive loads exceeding the adaptive tissue capacity and/or with insufficient recovery between applications, leading to progressive damage to affected structures (Mónico et al., 2020).

The young athlete still in the process of growth/development has fragility at the growth cartilages existing at the ends of the long bones, susceptible to injuries due to mechanical overload (Oliveira, 2007). This happens in contact sports where macro injuries are frequent, or in sports that require exhaustive repetitions of the same movements, such as figure skating. Figure skating generates repeated micro traumatisms whose cumulative effects exceed the capacity of biological adaptation of the osteoarticular structure to the re-quested efforts (Caine et al., 2006).

Young people exponentially increase the time of exposure to risk as competition approaches. Therefore, the increase in the athlete's time and training intensity should be gradual, so as not to create additional risks of injury to the young person (Oliveira, 2007). We went to test hypotheses 2 and 3, that is, how the number of times you train, and the level of competition influence the number of PC. To reach a level of sports practice, a high number of hours of training is necessary. So, we went to study the average number of weekly hours spent on each skating style. Regarding the practice of free skating, it took an average of two to five hours, in mandatory figures it was usual to practice in equal percentage (40.0%) between two to five hours and five to ten hours, in solo dance and show & precision the time spent was typically five to ten hours. All tournaments per week that trained between 25 hours and events in five weeks between ten hours/or weeks participated in more tournaments and district and/or national days, while training per week is superior with ten hours of associated national training. The number of workouts per week showed significant differences with PC. Those who train five to ten hours, have a higher number of PC. When increased the number of hours, the number of PC tends to increase, but when we exceed ten hours this does not happen, training above normal can also raise the precondition, the musculoskeletal system is more willing to that load (Calhoon & Fry, 1999; Kolt & Kirkby, 1999).

Analyzing other modalities, such as crossfit, participants who suffered injuries had a longer average time of physical activity. The injury rate in crossfit athletes was 3.1 injuries/1000 training hours (Hak et al., 2013). In weightlifting, according to Calhoon & Fry, (1999), the rate of acute and recurrent injuries was calculated at 3.3 injuries/1000 hours of exposure to weightlifting. In gymnastics, athletes presented a rate of 5.45 injuries/1000 hours of training (Kolt & Kirkby, 1999). When comparing with our data obtained, calculating the ratio of injuries per 1000 hours, we arrived at 12 injuries/1000 hours of training. All these data demonstrate that in different sports, which demand so much from the practitioners, that even involving different physiological and biomechanical capacities, strength, and differentiated training, Gymnastics and Skating are more likely to have musculoskeletal injuries, with a percentage per 1000 hours of training, higher when compared to other sports.

Finally, we tested the last hypothesis of how the material influences the PC number. The maintenance of the material is fundamental for the quality/technical performance of the athlete. Therefore, the boots are changed every 6 to 12 months to maintain good maintenance and maintain the skater's quality (Porter et al., 2007).

Considering the equipment, boots have significant differences concerning PC. Those who change boots after three or more years are at greater risk. About chassis, there are significant differences in chronic conditions, with a greater number of those who change chassis after three or more years. It is estimated that 50% to 78% of disabilities are preventable. Manufacturers are also working to increase quality control, as it has been estimated that up to 20% of skating boots are defective (Porter et al., 2007)

Sports injuries are inherent to the sport, with different epidemiological studies showing the high prevalence of sports-related injuries, with almost all athletes having suffered at least one injury. In addition, a sports injury can jeopardize the sports career and affect an individual's financial, social, and/or health problems (Olmedilla et al., 2018). Consequently, preventing sports injuries is extremely important, with an epidemiological investigation being considered as the first step to be followed (van Mechelen et al., 1992). Furthermore, a team approach, including the skater, trainer, parents, and doctor, with the addition of a fitness coach, physiotherapist, nutritionist, sports psychologist, and orthopedist, as needed, may ensure healthier skaters (Porter et al., 2007).

In practice, this study is essential so that coaches, trainers and physicists and the entire multidisciplinary team that works with these athletes can improve their work, considering that participation habits will influence the appearance of PC and the number of them. It can often not be avoided but work to reduce the risk. In this way, there must be a complementary training without skates for muscle strengthening, of all the muscles indicated as the most affected, thus avoiding the greatest number of PC.

Limitations

Several limitations to our study are inherently linked to the chosen methodological design, which can limit the generalizability of the results. A primary limitation of this study is that it was retrospective. The possibility of a recall bias is a factor to consider, even when using a shorter time of 12 months. In addition, due to the study's retrospective nature, only an association between variables and PC could be established, not causality.

The self-reporting nature of the questionnaire and relying on the responders to answer truthfully should also be seen as a limitation. There was an implied assumption that all tutors and respondents completed their survey honestly, in a way that reflects their actual participation habits and status (with or without) of PC.

We could not validate the self-reported PC, relying on the honesty of respondents. However, in the case of CHC, self-reports are typically 90% valid, increasing the probability of being accurate. Nevertheless, a chance of misinterpretation of questions and incomplete responses should also not be excluded.

Furthermore, we do not feel that a possible overrepresentation of complaints may be due to the likelihood of skaters who had PC participating in the survey. The web-based questionnaire was publicized as a tool to study participation habits. Therefore, response bias was not expected.

Finally, a low response rate and a small sample size might compromise the generalizability of findings. However, to ensure sample representativeness, we used normative data from the FPP to compare the study sample with the general skating population regarding gender and category.

Conclusion

Our findings suggest that artistic roller-skating PC are frequent. Change coaches, the number of workouts per week, an increase training time, and the lack of material renewal are more likely to present PC. In addition, older athletes with a history of previous injuries were at greater risk of injury.

Athletes who train more regularly or in preparation for tests tend to have a lower incidence of injuries and/or PC.

The most common injuries in figure skating are musculoskeletal injuries and, frequently, repetitive strain injuries. The factors that contribute to these injuries are the skates, the training regime, the environmental factors, and highly competitive sports.

The greatest number of reports of injuries or PC are observed in the knees, followed by the back (mainly the lumbar region), ankles, and legs.

Recommendations for future studies

Analyze a larger sample and matched in terms of athletes by step and specific modality. Comparing with males, despite the low adherence to the modality by men, it would be interesting to compare the values with those of females. Analyze the mental health of athletes, through questionnaires, for example.

Author Contributions

Conceptualization, Jorge Bravo and João Paulo Sousa; Data curation, Jorge Bravo and João Paulo Sousa; Formal analysis, Jorge Bravo and João Paulo Sousa; Investigation, Carolina Alexandra Cabo; Methodology, Carolina Alexandra Cabo; Resources, Carolina Alexandra Cabo; Supervision, Jorge Bravo and João Paulo Sousa; Validation, Jorge Bravo and João Paulo Sousa; Visualization, Jorge Bravo and João Paulo Sousa; Writing – original draft, Carolina Alexandra Cabo; Writing – review & editing, Carolina Alexandra Cabo.

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Conflicts of Interest

The authors declare no conflict of interest.

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