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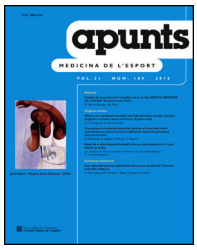

ORIGINAL ARTICLE

Incidence of injuries in competition of Leonese wrestling and associated factors (2005–2015)

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KEYWORDS
Wrestling;
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Abstract
Introduction: Traditional wrestling is considered a cultural heritage of humanity and it should be protected. The study of injuries and their associated factors can be useful to protect this heritage. The present study has as its aim an analysis of the incidence of injuries and the associated factors in competition of a traditional wrestling modality, ''Leonese wrestling'' (LW).
Material and methods: Observational, prospective cohort study that collected injuries during the summer seasons from 2005 through 2015. Incidence rates of injuries were calculated by 1000 athlete exposures (AEs) and as a function of age at initiation in LW, mid-season age, regularity or those who participated in the competitions of each season, winner type, and weight category. At the multivariate level, a generalized linear mixed model was used assuming the frequency of the injuries followed a Poisson distribution.
Results: A total of 308 wrestlers and 406 injuries were reported in 31,970 AEs. The incidence of injuries per 1000 AES was 3.0 (serious), 6.7 (moderate and serious) and 12.7 (total injuries registered). Higher incidence was observed among those who: were no regulars (IRR = 1.076; CI: 0.846–1.368), were considered non-winner type and started as teenager vs child (IRR = 1.115; CI: 0.856–1.452). Non-winner type wrestlers were at much higher risk of injuries in the semi heavy and heavy weight categories.

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Conclusions: The incidence of injuries in LW is consistent with that incidence expected in combat sports. Showing a low regularity, having started late in their practice, showing a non-winning profile and competing in the heavy weight category are injury risk factors for LW wrestlers.

PALABRAS CLAVE
Lucha;
Incidencia;
Lesiones;
Estudio de cohorte

Incidencia de lesiones en la competición de Lucha Leonesa y Factores Asociados (2005-2015)

Resumen
Introducción: La lucha tradicional es considerada un patrimonio cultural de la humanidad que debe protegerse. El estudio de las lesiones y sus factores asociados puede favorecer la protección de este patrimonio. El presente estudio pretende analizar la incidencia de las lesiones y sus factores asociados en la competición de una modalidad de lucha tradicional: la Lucha Leonesa (LL).
Material y métodos: Estudio observacional, prospectivo y de cohorte, que recolectó las lesiones ocurridas durante las competiciones de verano entre 2005 y 2015. La incidencia de lesiones fue calculada por cada 1000 atletas/expuestos (AEs), en función de la edad de iniciación a la LL, edad en el momento de la competición, regularidad de los participantes en la competición, perfil ganador y categoría de peso. Se utilizó un análisis multivariante mediante un modelo mixto lineal generalizado, asumiendo que las lesiones seguían una distribución de Poisson.
Resultados: Se registraron 308 luchadores y 406 lesiones en 31.970 AEs. La incidencia de lesiones por cada 1000 AEs fue de 3 lesiones (graves), 6,7 (moderadas y graves) y 12,7 (en el total de lesiones registradas). Se observó una mayor incidencia en aquellos luchadores: no regulares (IRR = 1,076; IC: 0,846-1,368), con perfil no ganador y los que se iniciaron en la lucha de adolescentes (IRR = 1,115; IC: 0,856-1,452). Los luchadores con perfil no ganador tuvieron un mayor riesgo de lesiones en las categorías de semipesados y pesados.
Conclusiones: La incidencia de lesiones en la LL es consistente con la incidencia esperada en otros deportes de contacto. La ausencia de regularidad a la hora de competir, haberse iniciado tarde en la lucha, mostrar un perfil no ganador y competir en la categoría de los pesos pesados, son factores que se asocian al riesgo de presentar una lesión en sus practicantes.

Introduction

Traditional wrestling is considered an intangible cultural heritage that should be recognized and protected.[1] One of the forms of wrestling that has the longest history despite not having the status of an Olympic sport is belt wrestling.[2] Among the varieties of this type of sport, Leonese wrestling or *aluche* holds a prominent place, being officially recognized by United World Wrestling (UWW), the European Traditional Wrestling Association (AELT) and the International Belt Wrestling Association (IBWA).[3] Leonese wrestling is a combat sport in which two participants, with a set hold on their opponent's leather belt, attempt to throw their opponent over by means of a series of Leonese wrestling skills and techniques.[4] The winner is the wrestler who after a fixed period of combat has gained the higher score or the person who first achieves two full falls or four points. The way of scoring depends on the type of fall.[5]

As a combat sport, it is naturally not free from injuries, many of which might be preventable.[6] A study of the incidence of such lesions and the factors behind them in this form of fighting sport might be of considerable use for a number of reasons like develop effective preventive measures[7] avoid premature retirement of wrestlers increasing the number of participants and encouraging the practice of a physical activity good for health, especially among the young.[4,8] Besides the various forms of belt wrestling share an internal logic and a set of technical and tactical actions that are quite similar from one to another, hence this may serve to develop preventive strategies for other similar types of wrestling (i.e. judo). On the other hand, it has also had in mind the mandate from the International Olympic Committee (IOC) to prevent injuries so as to encourage participation in safe sport,[9] and would make a significant contribution to protecting and perpetuating a unique cultural heritage.

With this in view, the present study has as its aim an analysis of the incidence of injuries and the associated factors in competition of a traditional wrestling modality, ''Leonese Wrestling'' (LW).

Material and methods

Study design

An observational, prospective cohorts study was conducted of official competitions (known as *corros*) for seniors (16 years of age or older) in the male summer leagues between 2005 and 2015. There were 25–38 *corros* per season. Mid season age is the age of the wrestler since 1st of July.

Injury criteria

The injuries were defined as any action arising in a fight that through harm done to a wrestler that prevented the bout from continuing or required it to be halted for medical attention to be provided, which for precautionary reasons excluded making any effort to train or compete in other bouts or similar activities for at least the following twenty-four hours.[10]

A bout begins with two fighters in the presence of an arbitrator. Wrestlers begin fighting from a position of chest to chest grip and will perform several techniques knows as *mañas*. The maximum duration up to the semi-finals will be 1 min 30 s, while the semi-finals and the finals will last a maximum of 3 min. The score is obtained by falls. The difference between falls and bouts is known as *Falls differences*.

Injury classification

Slight injuries were those which required less than a week for recovery. Moderate injuries involved over one week but not more than four to get over, while serious injuries took four or more weeks for recovery.[11]

Athlete-exposure

An athlete-exposure (AE) was defined by the Injury Surveillance System (ISS) as one athlete participating in one competition in which there was exposure to the possibility of athletic injury.[12]

Data collection and injury report form

The information was obtained directly from competitions on the basis of statements by the medical services covering them, of reports and assistance from friendly societies providing accident insurance, and of personal interviews at the end of each season.[6] The data presented an unbalanced study design with repeated measures, given that not all wrestlers were observed for the same number of seasons, and that the number of matches per season varied from one wrestler to another. The possible risk factors for injuries considered were: age of wrestler, regularity, winner type, and weight category (light up to 67.50 kg; medium 67.51 kg up to 77.50 kg, semi-heavy 77.51 kg up to 88.50 kg, and heavy over 88.51 kg). The binary variable ''regularity'' referred to regular participation in *corros*. Wrestlers were considered regular when they participated in at least two-thirds of the *corros* in each season which were open for their participation. While wrestlers were incapacitated by injuries, no account was taken of the *corros* in which they did not participate in calculating this two-thirds ratio. The variable 'winner type' was defined as a function of the falls during a season and set to 'yes' if the wrestler had more falls in favour than against; otherwise, the value of winner type was set to 'no'.

Confidentiality and ethics approval

Informed consent was requested and obtained from all the wrestlers to gain access to information about their injuries. The study was approved by the ethics committee of the University of Leon and was conducted in compliance with the standards of the Declaration of Helsinki[13] and following the guidelines of the European Community for Good Clinical Practice (111/3976/88 July 1990) and the Spanish legal framework for clinical research humans (Royal Decree 561/1993 on clinical trials).

Statistical analysis

A descriptive study of all variables of interest was carried out: in the case of categorical variables, absolute and relative frequencies are presented, and in the case of numeric variables, measures of central tendency (mean and median) and of statistical dispersion (standard deviation, standard error, inter-quartile range, and range) were calculated. The incidence rates for injuries were calculated in terms of cases per 1000 AEs both for the entire population and as a function of age at the mid-season, age at initiation into Leonese wrestling, regularity, winner type, and weight category, respectively. To study the possible risk factors for the incidence of injuries at the multivariate level, a generalized linear mixed model (GLMM) was used assuming the frequency of the injuries followed a Poisson distribution.[14,15] As the offset of this model the logarithm of the number of athletic exposures was used. All statistical analyses were performed with the statistical package R (The R Foundation for Statistical Computing, Vienna, Austria), version 3.1.1. In particular, the R package lme4 was used to fit the GLMMs. Statistical significance was set at $p < 0.05$.

Results

The total number of wrestlers taking part in the official summer Leonese wrestling competitions during the seasons studied was 308. The number of wrestlers participating varied from 111 in the season with the smallest contingent to 145 in the season with the largest. As may be seen from Table 1, wrestlers were mainly young (<25 years). They had generally started wrestling before reaching adolescence (<14 years). Participation in the competition was not a regular habit for most of the wrestlers, who did not take part in even half of the seasons considered and did not attend even half the official *corros* in each season. Three-quarters of the wrestlers did not complete as many as two bouts in each *corro* and an even higher proportion had a negative falls average.

Table 1 Characteristics of wrestlers relative to participation in competitions in the period from 2005 to 2015.

Measurement (units)	Minimum	P25	Median	P75	Maximum	Mean	SD[a]
Seasons (number)	1	1	2	6	11	3.7	3.1
Competitions (number)	1	5	20	74.2	325	52.3	70.4
Competitions/season (number)	1	3	9.3	16.7	29.6	10.5	8.0
Bouts (number)	0.5	3.5	12.5	60.6	510	51.9	88.6
Bouts/season (number)	0.5	2	6.7	12.3	51.6	9.1	9.1
Bouts/corros (number)	0.5	0.5	0.7	1	2	0.8	0.3
Falls in favour (number)	0	2.5	13.5	88.6	1996	115	268
Falls against (number)	0	11.4	41.2	168	778	115	154
Falls difference (number)	−1992	−86.5	−10.5	−1	4	−112	267
Falls difference/bout (number)	−2.1	−0.8	−0.5	−0.1	1	−0.4	0.6
Starting age (years)	4	9	13	19	54	15.3	8.0
Mid-season age (years)	16	19.5	22.5	28	54	24.4	6.9

[a] SD: standard deviation.

Incidence of injuries

A total of 406 lesions were recorded. Of these, 97 were serious, that is approximately one out of every five injuries; while 118 were moderate, one out of every three, and 191 slight, one out of two. During the same period a total of 31,970 AEs were noted (15,985 bouts). Hence, the incidence of lesions per thousand AEs was 3.0 serious, 6.7 moderate and serious taken together, and 12.7 was the figure for over all types of injury. As can be observed from Table 2, the incidences of injuries were higher in the ≥30 age group (13.7), in those who started *aluche* wrestling as teenager (14.7), in those with a negative average fall ratio (14.8), those who fought in under 66% of the *corros* each season (non-regularity) (15.2) and those in the heavy weight category (15.3). The highest incidence corresponded to wrestlers in the heavy weight category with a negative average fall differential (21.5).

Multivariate analysis

Table 3 shows the generalized linear mixed model for all types of injuries which includes all variables of interest. According to this model, the variables associated with the incidence of injuries are weight category, regularity and winner type. In addition, the model includes the interaction between weight category and winner type.

In order to facilitate the interpretation, Table 2 gives an account of the model parameters and their interaction in terms of incidence rate ratios (IRR). Adjusted for the remaining variables in the model, there are higher incidence rates for injuries (even though not statistically significant at a 0.05 level) among non-regular wrestlers (compared with regular wrestlers; IRR: 1.076; 95% CI: 0.846–1.368) and among wrestlers who started their involvement with Leonese wrestling as teenagers (IRR: 1.115; 95% CI: 0.856–1.452). The statistical interaction between winner type and weight category implies that non-winner type wrestlers are at much higher risk of injuries than winner type wrestlers in the semi-heavy (IRR: 1.496; 95% CI: 0.910–2.459) and heavy weight categories (IRR: 1.937; 95% CI: 1.149–3.264), whereas the differences are not statistically significant in the light (IRR: 0.782; 95% CI: 0.505–1.219) and medium weight categories (IRR: 1.179; 95% CI: 0.788–1.766), as is shown in Fig. 1.

Incidence of moderate and severe injuries

They were more frequent in the 21–25 age group (7.68), in those who started *aluche* wresting as adolescents (8.00), in those with negative average fall differentials (7.92), in those who did not fight in at least 66% of the *corros* each season (8.84) and in the light weight category (7.38). The highest incidence was found among wrestlers in the heavy category with negative average fall ratios (9.56). Considering only moderate and severe injuries, the model obtained was as shown in Table 2 and Fig. 2. According to this, the incidence of severe and moderate injuries was associated with winner type and age at the start of the season.

It can be seen that, when adjustment is made for the remaining variables, non-winner type wrestlers were at greater risk than winner type wrestlers (IRR: 1.549; 95% CI: 1.063–2.258). In addition, wrestlers older than 20 years at the start of the season were at greater risk of moderate and severe injuries than those aged 20 or under (Table 2).

Discussion

There is scant research about traditional wrestling and very few studies have been published regarding the incidence of injuries and associated factors. Analytic studies assessing risk factors by means of a standard methodology are even less common, and it would appear that there are none that have run over as long a period as eleven years. The present paper covers the incidence of injuries in one traditional form of wrestling, using a standard method based on the number of lesions per 1000 AEs. This renders it easier to make comparisons with other combat sports and even with other sports disciplines.[12]

Multilevel data structures arise in longitudinal studies where measurements are clustered within individuals (wrestlers in our study). The statistical methods commonly

Table 2 Incidence of all injuries, severe and moderate injuries and incidence rate ratios of variables included in the generalized linear mixed model.

Variables (units)	*N*	All injuries				Severe and moderate injuries			
		Injuries	AEs	Rate (95%CI)	IRR (95%CI)	Injuries	AEs	Rate (95% IC)	IRR (95% CI)
Age (years)									
≤20	485	109	9099	11.98 (9.84–14.45)		54	9099	5.93 (4.46–7.74)	
21–25	441	143	10,673	13.40 (11.29–15.78)		82	10,673	7.68 (6.11–9.54)	
26–30	270	85	7160	11.87 (9.48–14.68)		48	7160	6.70 (4.94–8.89)	
>30	225	69	5038	13.70 (10.66–17.33)		31	5038	6.15 (4.18–8.73)	
Starting age									
Teenager (>14 years)	813	143	9744	14.68 (12.37–17.29)	1.115 (0.856–1.452)	78	9744	8.00 (6.33–9.99)	1.232 (0.862–1.759)
Child (<14 years)	608	263	22,226	11.83 (10.45–13.35)	1	137	22,226	6.16 (5.18–7.29)	1
Fall winner									
Yes	388	184	16,943	10.86 (9.35–12.55)		96	16,943	5.67 (4.59–6.92)	
No	1033	222	15,027	14.77 (12.89–16.85)		119	15,027	7.92 (6.56–9.48)	
Regularity									
Yes	427	258	22,231	11.61 (10.23–13.11)	1	129	22,231	5.80 (4.84–6.89)	1
No	994	148	9739	15.20 (12.85–17.85)	1.076 (0.846–1.368)	86	9739	8.83 (7.06–10.91)	1.229 (0.882–1.712)
Weight category									
Light (<67.50 kg)	321	108	8675	12.45 (10.21–15.03)		64	8675	7.38 (5.68–9.42)	
Medium (67.51–77.50 kg)	467	119	9949	11.96 (9.91–14.31)		67	9949	6.73 (5.22–8.55)	
Semi-heavy (77.51–88.50 kg)	371	92	7645	12.03 (9.70–14.76)		49	7645	6.41 (4.74–8.47)	
Heavy (>88.50 kg)	262	87	5701	15.26 (12.22–18.82)		35	5701	6.14 (4.28–8.54)	
Category fall winner (yes/no)									
Light, yes	85	60	4481	13.39 (10.22–17.24)	1	33	4481	7.36 (5.07–10.34)	1
Light, no	236	48	4194	11.44 (8.44–15.17)	0.782 (0.502–1.219)	31	4194	7.39 (5.02–10.49)	0.811 (0.455–1.446)
Medium, yes	126	56	5354	10.46 (7.90–13.58)	1	31	5354	5.79 (3.93–8.22)	1
Medium, no	341	63	4595	13.71 (10.54–17.54)	1.179 (0.788–1.766)	36	4595	7.83 (5.49–10.85)	1.492 (0.691–3.221)
Semi-heavy, yes	94	35	3917	8.94 (6.22–12.43)	1	21	3917	5.36 (3.32–8.20)	1
Semi-heavy, no	277	57	3728	15.29 (11.58–19.81)	1.496 (0.910–2.459)	28	3728	7.51 (4.99–10.86)	1.348 (0.568–3.201)
Heavy, yes	83	33	3191	10.34 (7.12–14.52)	1	11	3191	3.45 (1.72–6.17)	1
Heavy, no	179	54	2510	21.51 (16.16–28.07)	1.937 (1.149–3.264)	24	2510	9.56 (6.13–14.23)	2.818 (1.063–7.475)

Table 3 Parameter estimates in the generalized linear mixed model for both all types of injuries and severe and moderate injuries.

Coefficients	All injuries			Several and moderate injuries		
	Estimate	SE[a]	*p*-Value	Estimate	SE[a]	*p*-Value[b]
Intercept	−4.241	0.195	<0.001	−4.773	0.263	<0.001
Regularity (Ref.[b]: yes)	0.073	0.123	0.552	0.207	0.169	0.222
Initiation (Ref.[b]: teenager)	−0.108	0.135	0.422	−0.208	0.182	0.253
Weight category (Ref.[b]: light)						
Medium	−0.234	0.227	0.304	−0.311	0.305	0.308
Semi-heavy	−0.325	0.268	0.225	−0.23	0.352	0.513
Heavy	−0.290	0.276	0.293	−0.782	0.412	0.058
Winner type (Ref.[c]: yes)	−0.247	0.226	0.275	−0.210	0.295	0.477
Interaction terms (winner type × weight)						
No × medium	0.414	0.298	0.164	0.398	0.393	0.310
No × semi heavy	0.650	0.334	0.052	0.299	0.441	0.678
No × heavy	0.910	0.345	0.008	1.039	0.498	0.679
Variance of random effect	0.139			0.259		
Dispersion parameter	1.525			1.643		

[a] SE: standard error.
[b] *p*-Value <0.05 is statistically significant.
[c] Ref: reference.

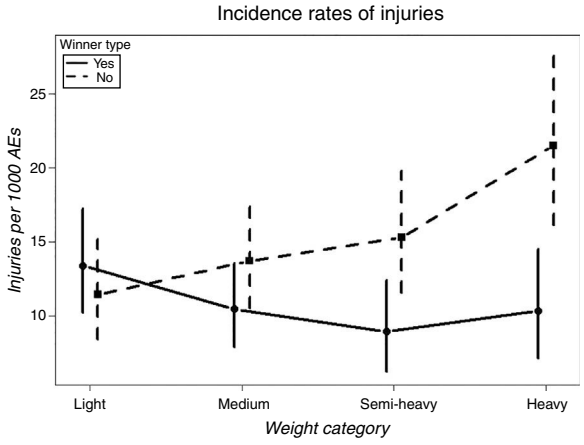

Figure 1 The statistical interaction between winner type and weight category of injuries. Average values (SD).

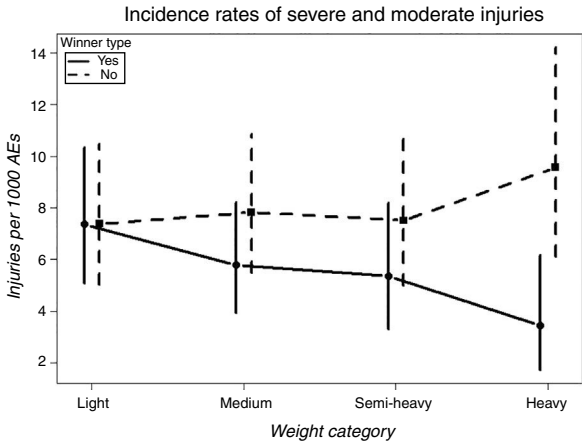

Figure 2 The statistical interaction between winner type and weight category of severe and moderate injuries. Average values (SD).

used in medical literature focus on generalized linear models (GLMs) such as counts or proportions. In sports sciences and epidemiology, the data are often shown repeatedly. Even though sports injuries are often recurrent, only a small number of studies consider the correlation structure of recurrent events. Future studies should consider recurrent injuries and apply the appropriate model. Ignoring the correlation of observations between wrestlers may, for example, lead to an underestimation of the standard error. For this reason, sports researchers have started to use statistical models such as GLMM that take into account the heterogeneity between teams.[15–17]

The incidence of injuries in this traditional form of wrestling is consistent with the incidence expected in combat sports and hence could be reduced. Lack of regularity and starting late in the practice of this sport are risk factors for the incidence of injuries. Technical quality is particularly relevant for the heavy weight category.

The practice of Leonese wrestling, just like other combat sports or indeed sports in general, has obvious positive effects on health, helps participants gain physical and mental strength, teaches self-discipline, moulds the character and increases self-esteem.[18,19] However, sports also have negative effects upon the health of participants to which attention should be paid, particularly in combat sports, which show higher injury rates as compared with other sports disciplines.[11,20] Among Olympic sports and during Olympic Games, combat sports such as judo and wrestling lie in the intermediate to high zone in respect of the proportion of participants injured, whilst taekwondo comes either first or second.[21,22]

The technical and competitive characteristics of Leonese wrestling mean that it is most like judo and freestyle wrestling, in which incidences per exposure are very variable. In American universities and high schools the injury rate in wrestling runs from 2.3 to 9.6 lesions per 1000 AEs, with a clustering in the range 7.3 to 9.6 per 1000 AEs, that is, an incidence that is slightly lower than the rate observed in the present study.[10] However, as compared with judo championships, incidences in *aluche* are lower, since for judo the rates range between 25.2 and 72.1 lesions per 1000 AEs.[23,24] Leonese wrestling thus had incidences a little higher than in high school wrestling but lower than in judo, and hence within the expected range. The rate found was lower than that reported for this same sport in the league for teams, where over the course of seven seasons an incidence of 18.1 per 1000 AEs was recorded.[7] Nevertheless, it may be considered a high rate, especially in a context of amateur competition in which the frequency of injuries ought to be lower than in sports that are more professional or that require greater dedication, where competition is very strong.[25] Thus, the incidences found can be seen as high and it is likely that an appreciable number of injuries might be avoidable, either through modifications in the rules, or the technical, physical and psychological preparation of wrestlers, or both.[4,26]

A finding of interest of this research is the fact that non-regular wrestlers suffered between 25% and 30% more injuries than those considered regulars, and those with a negative average fall differential showed an increased incidence of lesions, especially in heavier weight categories, with an injury rate varying from 50% to 80% higher. In this regard, it has been stated that practising sport at a competitive level, and particularly combat sports, demands an appropriate physical, technical and psychological state.[27,28] Therefore, it could be hypothesized that in comparison with regular wrestlers, non-regular ones could show a decreased level of fitness, since it has been observed that regular participation in sports is associated with enhanced physical fitness.[29] This low level of fitness, would increase injury risk, as previously observed in combat sports.[30] Similarly, the fact that non-winning type wrestlers showed a higher injury rate could be explained on the basis of the mastery of LL techniques. In this regard, it can be expected that these wrestlers show a lower sport ability, that in turn increases the possibility of suffering a sport injury, since a higher injury risk has been observed among those sport practitioners who do not have become technically proficient.[31] The fact that this reported injury risk were higher in the heavier weight categories is an unexpected finding. Indeed, other authors have not observed a higher incidence of lesions in the heavier weight categories of other combat sports, for instance Green et al. for judo[25] or Jarret et al. for wrestling.[10] Nonetheless, it would appear that the higher the weight, the greater the accumulated energy exerted by wrestlers in colliding or twisting, so that the likelihood of an injury should be greater.

Another factor associated with injuries is age. In this study the incidence of severe and moderate lesions showed a climb as age rose. It is a constant that the greater one's age the higher the chances of suffering an injury,[27] although other authors have discovered that in combat sports in particular, it is the younger participants that are more often hurt.[32] This contradictory finding can be explained on the bases of the particular characteristics of LW. As a traditional form of wrestling, LW has a playful and leisure nature and the wrestlers are amateurs and they do not devote a great amount of time to prepare for the competition. Besides, it should be noted that LW wrestlers take part in large number of competitions and it is obvious that the greater the exposure, the greater the danger of getting hurt. Even competing in the finals, where the combats last three minutes was associated to a higher injury risk than competing up to the semi-finals, where the combats last 90 s. Similarly, although the non-regular and non-winning type wrestlers were the ones who showed a greater injury risk, the data obtained in the present research indicated that regular and wining type wrestlers suffered a high number of injuries. For instance, one-fourth of the wrestlers had a neutral or a positive fall differential and yet a total of the order of 40% of injuries. These findings indicate that exposure is a factor that should be taken into account.

Hence, when attempts are made to reduce the injury rate, the present findings highlight the importance of limiting the number of competitions as a way to reduce injury exposure. For instance, in other combat sports where an increasing age and an increasing number of fights were both found to be significant predictors of injury, it has been proposed to include restrictions of eligibility to fight based on age and boxing bout exposure.[33] Similarly, it seems advisable to increase the level of fitness and the technical ability of the less skilled wrestlers in order to reduce the possibility of suffering an injury.[34] For instance, in judo it has been proposed that improving upper body muscular strength and flexibility could be a useful approach to reduce injury risk.[26] Finally, another plausible strategy would be to force wrestlers to take part in a minimum number of ongoing competitions in order to increase their regularity.

Conclusions

The injury rate registered in Leonese wrestling competitions is high and lies within the range expected in combat sports. Those wrestlers who did not take part in competitions on regular basis, who started late in the practice, and who had a non-winning profile were the ones who showed a greater injury risk. These data can be of help for developing injury prevention strategies aimed at increasing the safety of this traditional wrestling modality.

Conflict of interest

The authors have no conflicts of interest to declare.

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