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## ORIGINAL

### MODIFYING TRAINING VOLUME AND INTENSITY TO PREVENT FUTSAL INJURIES

### MODIFICACIÓN DEL VOLUMEN-INTENSIDAD COMO MEDIDA PREVENTIVA DE LESIONES EN FÚTBOL SALA

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DERSA: after the Spanish terms "*deporte, ergonomía, salud*" (sports, ergonomics and health). Emerging group recognized by the Regional Government of Aragon.

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#### ABSTRACT

A number of methods have been developed over the years to control training volumes and optimize player performance. The prevention of injuries has become a priority for coaching staffs. Some authors consider training volume, intensity and frequency as key to the prevention of sports injuries. The goal of this study is to assess the effectiveness of a variety of preventive measures focused on volume, intensity and frequency that were included into the training program of a professional futsal team. The number of injuries sustained was

compared against that in the same team in other season. The sample included 12 futsal players. The results obtained show that reducing monthly and total training volume, lowering the number of high-intensity microcycles and decreasing the number of weekly training sessions were effective in reducing injury occurrence in one season as compared to the other season.

**KEY WORDS:** Futsal, injuries, injury incidence, preventive measures, quantification of training.

## RESUMEN

A lo largo de los años se han desarrollado distintas metodologías para controlar las cargas de entrenamiento y optimizar el rendimiento. La prevención de lesiones se ha convertido en uno de los grandes objetivos del cuerpo técnico. Algunos estudios plantean que variables como el volumen de trabajo, la intensidad y la frecuencia en su realización pueden ser la clave para lograrlo. El propósito de este trabajo es analizar en qué magnitud han influido las diferentes medidas preventivas adoptadas referidas a estas variables en el plan de entrenamiento de un equipo profesional de fútbol sala y comprobar si existen diferencias con respecto a otra temporada del mismo equipo y de las mismas características. La muestra estuvo compuesta por 12 jugadores. Los resultados muestran una disminución del volumen mensual y total, del número de microciclos de mayor intensidad y del número de sesiones semanales entre la primera y la segunda temporada. Las medidas adoptadas han sido efectivas para disminuir la incidencia lesional.

**PALABRAS CLAVE:** Fútbol sala, lesiones, incidencia lesional, medidas preventivas, cuantificación del entrenamiento.

## INTRODUCTION

Player fitness and performance in training sessions and competitions determines training planning. Therefore, injury prevention is crucial for the coaching staff.

Reducing injuries can be considered an integral part of the preparation process in any sport. This preparation process is based on training programs that control the training volume in order to help players keep fit, improve their game skills, develop the psychological abilities required and maintain their health status<sup>1</sup>. The higher the level of competition, the greater the impact of injuries in economic and sporting terms<sup>2</sup>. It is important to control, focus, balance and impose the adequate training load to improve player's performance during competition<sup>3,4</sup>.

Consequently, it is essential to assess the impact of training load to optimize player performance, prevent injuries related either to overtraining or lack of training, and ensure that players compete with all the guarantees and in an optimal fitness state<sup>4-5</sup>. A number of methods have been developed over the years to control training loads both quantitatively and qualitatively<sup>6-11</sup>. Some

authors have pointed training load as a major cause of sports injuries<sup>12,13</sup> and a range of variables such as training volume, intensity and frequency have been identified as key to the prevention of injuries.

Once injury occurrence and evolution have been associated with a specific sports modality and context<sup>4,14</sup> further studies are necessary to establish a connection between injuries and the variables controlled in training programs. Then, training patterns can be modified consequently to optimize player and team performance by reducing the occurrence of injuries and the number of training sessions and matches missed<sup>4,12,15</sup>.

In our 2009 study titled *Incidencia lesional y su repercusión en la planificación del entrenamiento en fútbol sala (Injury occurrence and impact on training programs in futsal)*<sup>4</sup> we found an injury occurrence significantly above that reported in previous studies<sup>14-26</sup>. This led us to implement a variety of preventive measures basing on the prevention plans proposed in previous studies<sup>5,27</sup> to reduce injury occurrence and the number of matches and training sessions missed.

## OBJECTIVE

The objective of this study is to assess the effectiveness of different preventive measures in reducing injury occurrence in a season as compared to other season under similar conditions.

## MATERIALS AND METHODS

This is a comparative, longitudinal study assessing injury occurrence in a first division futsal team over two seasons: the 2004-2005 Season (SA) and the 2011-2012 Season (SB). The futsal team selected was the first team of the Spanish A.D.Sala-10, which was composed of 12 players.

Informed consent was obtained from all players. Participants were aware that they were free to withdraw from the study at any time.

Statistical analysis was performed using the SPSS package version 19 (under the University of Zaragoza's license). Descriptive analysis of categorical variables is expressed as percentages. The association (or independence) between categorical variables was determined by Pearson's Chi-square test ( $\chi^2$ ). When a significant correlation was observed, adjusted residuals (AR, as defined by Haberman) were obtained to identify the categories that cause statistical significance.

Correlations were determined using Chi-square test (C). Given the characteristics of the sample, normal distribution was not expected. Therefore, correlations between quantitative variables were assessed by Spearman's rho ( $\rho$ )<sup>28,29</sup>. Statistical significance was established at  $p < 0.05$ . Data are shown in tables.

We collected all variables considered in a season planning: training volume, contents, matches and training seasons missed, injuries, illnesses, etc.

Injury data were collected according to the guidelines included in the agreement statement of the Injury Consensus Group prepared by the FIFA Medical Assessment and Research Centre (F-MARC). The use of a standardized data collection methodology allowed us to compare our results with those of previous studies that used the same methodology, thus preventing the problems associated with the use of different data collection procedures<sup>30</sup>.

We recorded all injuries resulting in one or several training sessions / matches missed.

To ensure the comparability of results, we focused on the same team, used the same data collection method and employed the same observer in two seasons with similar characteristics (Table 1). Data collection could not be performed with all the guarantees until the 2011–2012 Season due to the challenges of standardizing data collection and measuring methods.

**Table 1. Season and team characteristics**

	<b>SA</b>	<b>SB</b>	<b>DIFFERENCES</b>
<b>Duration (days)</b>	273	273	0
<b>Training days</b>	203	191	-12
<b>Days off</b>	70	82	+12
<b>Sessions (no matches)</b>	222	214	-8
<b>Official matches</b>	31	30	-1
<b>Friendlies</b>	12	8	-4
<b>Matches</b>	43	38	-5
<b>Total Sessions</b>	265	252	-13
<b>Density (session/day)</b>	6.0	0.92	-0.05
<b>Weeks (microcycles)</b>	39	39	0
<b>Ascending series week</b>	21	11	-10
<b>Maintenance Training</b>	11	19	+8
<b>Descending series week</b>	7	9	+2
<b>Volume (min/h)</b>	1.1–2.6). 456h	24,655 min/ 411h	-2,730min/ -45h
<b>Position in the League</b>	6 <sup>o</sup>	8 <sup>o</sup>	

SA: 2004-2005 Season; SB: 2011–2012 Season.

Although competition schedules differed between seasons, their characteristics yield very similar results. In both seasons, the team accomplished its primary goal: qualifying for the play-offs for the title of the National league, which is achieved by the top eight teams. These data show that the two seasons had similar characteristics, which ensured the comparability of the results obtained in each season.

The study subjects played at the same competition level and followed comparable training methods, which are relevant factors to injury occurrence<sup>31</sup>.

The measures implemented to reduce injury incidence in SB were:

- Reducing overall season training volume.

- Reducing training intensity by diminishing the number of ascending microcycles and increasing the number of maintenance microcycles.

Other measures applied were:

- Players were asked to keep a daily log of perceived exertion and intensity.
- Respecting the healing process of injuries before resuming training with the team.
- Integrating injury prevention workouts.

### Competition Day and Recovery Time

It is the competition schedule what determines training loads over the season. In SA, matches were generally played on Saturday afternoon, and training was resumed on Monday afternoon. Conversely, in SB, over half of the matches were played on Friday evening, and training was generally resumed on Monday afternoon, although players were instructed to perform a recovery session on their own.

Thus players in SB had more time to recover –specifically, a day more– which allowed them to recover from minor injuries before resuming team training. On the other hand, as players in SA had a day less to recover, they might start the week with an injury. This also means that more intense training loads can be imposed from Monday to Saturday (SA) than from Monday to Friday (game day) (SB).

This study is aimed at achieving a better understanding of the causes of injury and determining the relationship between injuries and training variables such as training volume, type of week and microcycle (ascending, maintenance, descending).

## RESULTS

**Table 2.** *Minutes missed*

Minutes missed.	SA	%	SB	%
<b>Due to injury</b>	6.0	88.98	6,360	82.28
<b>Due to illness</b>	3,900	11.02	1,370	17.72
<b>Total</b>	35,400	100	7,730	100

SA: 2004-2005 Season SB 2011–2012 Season.

**Table 3.** *Season matches –Players employed and injured.*

	SA	SB
<b>Official matches</b>	31	30
<b>Players per match</b>	8.3	8.3
<b>Injured players season matches</b>	40 (10 players)	9 (4 players)

SA: 2004-2005 Season; SB: 2011–2012 Season.

**Table 4.** Volume, time of exposure, number of injuries and injury incidence

Month	SA						SB					
	Volume (min.)	T' exp (h)	% vol.	No. injuries	% injuries	Injury inc.	Volume (min.)	T' exp (h)	% vol.	No. injuries	% injuries	Injury inc.
Aug.	4,360	872	15.92	27	25	30.96	3,990	798	16.18	3	11.54	3.76
Sept.	4,120	824	15.04	17	15.74	20.63	2,860	572	11.6	3	11.54	5.24
Oct.	2,775	555	10.13	12	11.11	21.62	2,600	520	10.55	3	11.54	5.77
Nov.	3,130	626	11.43	8	7.407	12.78	2,605	521	10.57	3	11.54	5.76
Dec.	2,420	484	8.837	12	11.11	24.79	2,640	528	10.71	1	3.846	1.89
Jan.	2,630	526	9.604	7	6.48	13.31	1,675	335	6.794	3	11.54	8.96
Feb.	2,365	473	8.636	6	5.56	12.68	2,920	584	11.84	3	11.54	5.14
Mar.	2,670	534	9.75	11	10.19	20.60	2,180	436	8.842	1	3.846	2.29
Apr.	2,915	583	10.64	8	7.41	13.72	2,255	451	9.146	4	15.38	8.87
May		0	0	0	0		930	186	3.772	2	7.692	10.75
<b>Total</b>	<b>27,385</b>	<b>5.477</b>	<b>100</b>	<b>108</b>	<b>100</b>	<b>19.72</b>	<b>24,655</b>	<b>4.931</b>	<b>100</b>	<b>26</b>	<b>100</b>	<b>5.27</b>
<b>1–20 s</b>	<b>15,875</b>	<b>3.175</b>	<b>57.97</b>	<b>66</b>	<b>61.11</b>	<b>20.79</b>	<b>14,215</b>	<b>2.843</b>	<b>57.66</b>	<b>13</b>	<b>50.00</b>	<b>4.57</b>
<b>21–39 s</b>	<b>11,510</b>	<b>2.302</b>	<b>42.03</b>	<b>42</b>	<b>38.89</b>	<b>18.25</b>	<b>10,440</b>	<b>2.088</b>	<b>42.34</b>	<b>13</b>	<b>50.00</b>	<b>6.23</b>

Correlation between SA and SB volumes  $r=0.27$

Correlation between volume and Injury Inc. in SA  $r=0.38$

Correlation between volume and Injury Inc. in SB  $r=0.63$

SA: 2004-2005 Season; SB: 2011–2012 Season; Vol.: Volume; T' exp: Time of exposure (h); No. injuries: Number of injuries; Injury Inc.: Injury Incidence, Number of injuries sustained during the time of exposure. It is expressed as per 1,000 h. of exposure (Fuller C, Consensus 2006).

**Tabl5 2.** Microcycle–injury relationship

Micro	SA					SB					TOTAL	
	No.m	%m	No.inj.	% injuries	AR	No.m.	%m	No.inj.	% injuries	AR	No.	%
<b>Asc</b>	21	53.85	63	58.3	2.2	11	28.21	9	34.6	- 2.2	72	53.7
<b>Maint.</b>	11	28.21	24	22.2	- 3.6	19	48.72	15	57.7	3.6	39	29.1
<b>Des</b>	7	17.95	21	19.4	1.4	9	23.08	2	7.7	- 1.4	23	17.2
<b>Total</b>	39		108	100		39		26	100		134	100
$\chi^2 = 12,939. P = 0,002. C = 0,297. Cmax = 0.71$												

SA: 2004-2005 Season; SB: 2011-2012 Season; Micro (m): Microcycle; Asc: Ascending; Maint.: Maintenance; Des: Descending ; AR: Adjusted Residual.

## DISCUSSION

### Volume

The total training volumes were 27,385 and 24,655 min. in SA and SB, respectively. Training volume was 2,730 min/45h. higher in SA as compared to SB. This difference is visible in the first third of the season and in half of the microcycles of the season. The higher training volume imposed in SA –partly due to differences in competition schedules– might be the cause behind the higher incidence of injuries in SA, as suggested in previous studies<sup>12,13</sup>. Accordingly, some authors suggest that training volume, intensity and frequency may be key to the prevention of injuries.

The lower training volume in SB is due to the fact that competition matches were generally played on Saturdays, which means that players had more time to recover from injuries after the match. Thus, the weekly volume was adapted and the duration of the sessions was reduced.

Table 4 shows a linear decrease in injury incidence as the season progressed. These results are consistent with those obtained in previous studies<sup>2,17,21,32–34</sup>: injuries are more prevalent during the first part of the season. The reason is that players have had a long break and their fitness state is poorer. Therefore, at the beginning of the season players need more training volume to recover their fitness. The opposite occurs in the second half of the season: volume decreases, since the work done during the first half of the season makes long training sessions unnecessary, provided that the adequate intensity is maintained.

Training intensity was higher in the first quarter of SA as compared to SB.

### Monthly Volume-Injuries-Injury Incidence



*Season Volume–Injury Incidence* The correlation between season volume and injury incidence was  $r = 0.38$ , which indicates that the lower the training volume, the lower the injury incidence. In SB, the correlation was  $r = -0.63$ , a stronger relationship than in SA, although inverse. This means that the higher the volume, the lower the injury incidence. The cause of such an apparently contradictory circumstance is that the number of injuries was reduced so dramatically that any small change between months can cause wide variations.

In SB, there is great variability of values in January, April and May, with an abnormally high injury incidence. Also, it is to be noticed the low injury incidence in August. The cause behind these results is the urge to achieve enough points to meet the team's goals in January, April and May, and the preventive measures implemented in August to reduce the training volume and prevent minor injuries from becoming major problems.

We believe that the preventive measures adopted in SB had such an impact that they reversed the logical relationship identified in SA according to which the higher the training volume the higher the injury incidence. Thus, in SB, the lower the training volume, the higher the injury incidence.

*Volume in both seasons (E/h):*  $r = 0.27$  was obtained, a significantly low value due to the abnormal values obtained in SB in August –where values were much higher than in the other months–, and in May –where values were significantly lower than in the other months, since players trained only for two weeks. In SA, volume was high in the first two months (August and September), while in SB the volume was reduced significantly in September.

In SA, the highest percentage and number of injuries (25% and 15.74%, respectively) coincided with the months where the training volume was higher (August and September: 15.92% and 15.04%, respectively). On the other hand, the lowest number of injuries (5.56%) was observed in the month with the lowest training volume, February (8.64%). These results are consistent with those reported in other studies<sup>12,13</sup>, where the incidence of injuries gradually decreases as the season progresses, and the number of injuries grows when the training load is increased. This occurs mainly during the first weeks of training, when players have not yet adapted to the training sessions.

In SA the number of injuries grow in April, when the training volume is increased to prepare for the play-offs. As other studies<sup>15</sup>, we did not find a clear tendency, since the number of injuries peaked in March and May, when the team must make an effort to meet the goals of the season. The pressure exerted on players causes them more stress and fatigue at all levels, which are identified by many authors as extrinsic risk factors that should be considered<sup>16,18,19,35–38</sup>. The greater the stress, the higher the risk of injury<sup>39</sup>.

The homogeneous distribution observed throughout SB may be due to the reduction in the number of injuries. In SB, the training volume was not increased in the preparation for the play-offs to prevent injuries.



The injury incidence in SA (19.72 inj./1,000) was very high as compared to that reported in previous studies. The months with the highest injury incidence were August (30.96 inj./1,000), December (24.79 inj./1,000) and October (21.62 inj./1,000), while the month with the lowest injury incidence was February (5.56 inj./1,000). In SB the incidence of injuries was reduced significantly in all months (5.27 inj./1,000) with respect to SA. The incidence of injuries was higher in May (10.75 inj./1,000), January (8.96 inj./1,000) and April (8.87 les/1,000). However, the number of injuries in May might be lower because there were only two weeks of training in this month and the incidence increases as the time of exposure decreases. On the other hand, the months with the lowest incidence of injuries were December (1.89 les/1,000) and March (2.29 inj./1,000). The results obtained in other studies indicate that the incidence of injuries is higher during the preseason and decreases as the season progresses<sup>2,15,17,32-34,40</sup>.

When seasons are divided into two blocks –from week 1 to week 20 and from week 21 to week 39– no differences were found between the first and the second half of the season.

### **Matches Missed per Injury**

These results are reflected on competition matches: in SA, 10 players missed one or several matches due to an injury 40 times throughout the season. However, in SB only four players missed one or several matches, nine times. On the other hand, while in SA there were always one or two injured players with difficulties to compete, in SB almost all players were permanently available for competition with all the guarantees.

### **Type of Week (microcycles)**

It is important to distinguish the type of week where injuries were sustained. In team sports –where the competition has a duration of 9–10 months– players must maintain their fitness state as long as possible. To achieve this, specific stimuli are applied for players to attain their peak of fitness at different times<sup>1,4</sup>.

Chi-square test showed significant differences. The  $p=0.02$  (below 0.05) obtained when C and Cmax were calculated to verify whether the percentage of injuries per microcycle was maintained in both seasons, indicates a statistically significant difference between both seasons. According to the AR, which exceeds 1.96, in SA there were a higher proportion of injuries sustained during ascending microcycles (58.3%) than in SB (34.6%). On the other hand, in SB there was a higher proportion of injuries sustained in maintenance microcycles (57.7%) as compared to SA (22.2%). Notwithstanding the above and considering absolute values, the number of injuries decreased in SB.

In SA, 58.33% of injuries were sustained during ascending microcycles, 22.22% during maintenance cycles, and 19.44% during descending cycles. These data should be interpreted with caution, because if we calculate the percentage of cycle types, we will see that the percentage of injuries is very similar in both seasons. The greatest difference found in terms of number of injuries may be attributed to the reduction of training volume and intensity. This is confirmed by

the higher number of ascending microcycles –21 in SA and 11 in SB– and maintenance microcycles –11 in SA and 19 in SB.

## CONCLUSIONS

- There is a direct relationship between high training volumes and an increase in the incidence of injuries.
- There is a direct relationship between high training intensity and an increase in the incidence of injuries.
- The continuous adaptation of training volumes to the needs of the team and to the specific needs of each player is crucial to reduce the incidence of injuries.
- The measures adopted concerning training volume and intensity were effective in reducing injury incidence. However, further research is required since a percentage of correlation could be determined, as the preventive measures implemented were included into a broader injury prevention plan.

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