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**Original Article**

# Impact of a specialized conditioning program on the development of postural stability of soccer referees

JÁN HIANIK[1], JAROMÍR ŠIMONEK[2], PAVOL HORIČKA[3]
[1,2,3]Department of Physical Education & Sport, Faculty of Education, Constantine the Philosopher University, Nitra, SLOVAKIA

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**Abstract**
The aim of this study was to find out the impact of a specialized programme on the development of postural stability of soccer referees. A single-group controlled experimental design lasting for 52 weeks was used. The observed group was tested using the UEFA 20 battery (25 tests). When the specialized programme of exercises was not implemented in the reference period (27 weeks) the observed group significantly got worse (<.05) in active mobility and flexibility (-3.09 points), in passive mobility and flexibility (-4 pts) and in coordination and proprioception (-2.18 pts). Within the course of the six-month-long experimental period active mobility and flexibility (+3.82 pts) and passive mobility and flexibility (+6.27 pts) significantly improved (<.05). In order that referees avoided an increased number of injuries, authors recommend realization of specialized ComplexCore™ exercises at least three times a week. During the monthly cycle it is inevitable to increase the level of demandingness and the content of exercises for injury prevention.
**Keywords:** Soccer, soccer referee, assistant referee, postural stabilization, injury prevention programme

## Introduction

Postural stability is characterized by Kolář *et al.* (2009) as active gait counteracting the active external forces, which is controlled by the central nerve system. This muscular activity consolidates dynamic segments of the body against the activity of external forces. Postural stability does not act only against gravitation, but it is also a part of all movements. Every movement of the body segment causes generation of contraction muscular power necessary for overcoming the resistance. This is realized by the system of lever arrangement of segments of the human body on the whole kinematic system, where it activates reaction muscular strength. This reaction is aimed at reinforcing individual segments (joints), in order to be able to resist the effects of external forces. The „common frame“, which is the condition of all physical activities, is formed by thorax, abdomen, spine and girdles. Reactive stabilization function is in progress automatically and involuntarily. Postural pattern of stabilization is stored in the brain as a programme (Kolář, 2006).

In contrast with the recent past, the level of physical fitness of a soccer referee is considered to be a very significant factor, which affects the overall performance of the referee in a match (Hianik, 2009). Loading of soccer players correlates with the one of referees in a match (Weston *et al.*, 2007). In the course of refereeing there is a difference between physical activity and loading of the chief referee and the assistant referee. Loading of soccer referees in top leagues was observed by Mallo *et al.* (2008), Krustrup *et al.* (2009). They investigated differences between referees and their assistants, while finding a significant difference in the total distance covered by referees of different functions in a match (10.27 ± 0.90 compared to 6.76 ± 0.83 km) and in high intensity runs (1.92 ± 0.58 compared to 0.97 ± 0.22 km). Referees frequently used backward run (0.89 ± 0.37 km), while assistant referees sideways jog (1.54 ± 0.66 km). Krustrup *et al.* (2009) found in both referee´s functions significant difference also in average heart rate (HR). HR in referees averaged between 141 and 170 beats per minute, while in assistant referees between 105 and 157 beats per minute. Helsen and Bultynck (2004) present that on average, referees and assistant referees perform the matches at 85 ± 5% and 77 ± 7% of their maximal heart rate, respectively. Marked difference between loading of referee and assistant referee can be seen in the extent of the static phase (standing) in a match. Assistants stand for 15 to 30 minutes, while referees for 7 to 15 minutes. This means that intensive physical activities of referees frequently start from basic standing position, while their physical activity changes every 5 seconds (Weston *et al.*, 2006). Both the above mentioned factors have obviously been the main cause of frequent injuries of soccer referees. Bizzini *et al.* (2009) found that up to 40% referees recorded injuries of different character during their career. Obtained data proved incidence of 20.8 injuries per 1,000 hours of refereeing in a match. Weston *et al.* (2012) found only 18 injuries per 1,000 match hours in soccer referees. Arnasson *at al.* (2004) consider age and previous injury as the main risk factors for injury among elite soccer players.

In order to decrease the risk of injury the soccer referee has to go through a specialized training. Perfect warm-up as well as specialized strengthening of the „common frame“ of the body are important. They are


Corresponding Author JAROMÍR ŠIMONEK, E-mail: jsimonek@ukf.sk

realized by means of the programme ComplexCore™ (Jahoda and Mitterbauer, 2013). In our study effectiveness of the specialized programme (ComplexCore™) for the development of postural stability (active and passive mobility and flexibility; coordination and proprioception; strength) was verified.

**The aim**

The aim of our study was to find out the impact of the specialized programme ComplexCore™ on the development of postural stability of soccer referees.

**Methods**

Single-group controlled experiment was carried out for reaching the aim. Test battery UEFA 20 was used for finding the level of postural stability. Input data were obtained in December 2013, followed by reference period (27 weeks), in which referees went through classical training of the soccer referee according to the directions of UEFA. At the beginning of the experimental period in June 2014, second measurement was carried out. The special programme of exercises (ComplexCore™) for the development of postural stability was implemented during the period of 25 weeks. After the second period output data were obtained by testing.

Experimental design:

The group of experimental soccer referees (V=1,2,3,...11) was measured under identical conditions in the times t□, t□, t□. In the period Δt□ the experimental factor did not occur, while in the period Δt□ the experimental factor was implemented in the training of the experimental group (25 weeks).

no stimulus experimental factor

V(11) S (1-4) t□ ——————→ V(11) S (1-4) t□ ——————→ V(11) S (1-4) t□

t□ - t□ = reference period - 27 weeks

t□ – t□ = experimental period - 25 weeks

t□: input measurement – Dec. 8, 2013

t□: reference measurement – June 14, 2014

t□: output measurement – Dec. 6, 2014

(S1- S4): cases observed:

S□: performance in tests focusing on active mobility and flexibility.

S□: performance in tests focusing on passive mobility and flexibility.

S□: performance in tests focusing on coordination and proprioception.

S□: performance in tests focusing on strength.

The observed group was formed by referees from the group „Talent“, which consisted of 6 referees and 5 assistant referees. It was a selection of perspective referees for UEFA aged 22 to 24 years. The study was approved by the Faculty of Education Ethics Committee, with all volunteers providing written consent.

The specialized programme (Jahoda and Mitterbauer, 2013) for the development of postural stability consisted of 6 programmes of exercises of different levels of demandingness (level 1, level 1+, level 2, level 2+, level 3, level 3+). Every month referees obtained through application ComplexCore™ the programme of exercises, the correct realization of which could have been controlled on the cell phone. The referees obtained the simplest programme in month 1 (level 1), while the most demanding one in month 6 (level 3+). Exercises were performed three times a week. One training session lasted for 45 minutes. Overall time of performing exercises was 3,375 minutes. The obtained data were processed and evaluated using non-parametric ordinal Wilcoxon´s T- test, by which statistical significance of differences in the observed group was determined. The level of statistical significance was 5 %. Evaluation method of the reached level in the test battery (UEFA 20) contained point values 1, 3 and 5, while the lowest values meant higher level of performance in the indicators investigated. Extent of flexibility in joints was measured by means of goniometer.

**Results**

***Evaluation of the level of active mobility and flexibility***

Average value of active mobility and flexibility in the input measurement represented 15.18 pts, while at the end of the reference period a decrease in the value was recorded (18.27 pts). At the end of the experimental period, referees improved in active mobility and flexibility to the level of 14.45 pts (Table 1).

Table 1. Statistic characteristics of tests for active mobility and flexibility

| Active mobility and flexibility | | | |
|---|---|---|---|
| | **t0** | **t1** | **t2** |
| Arithmetic mean | 15.18 | 18.273 | 14.45 |
| Standard deviation | 1.888 | 4.315 | 3.357 |
| Median | 15.0 | 19.0 | 13.0 |
| Minimum | 13 | 11 | 11 |
| Maximum | 19 | 23 | 21 |
| Variation range | 6 | 12 | 10 |

In the reference period (t□ - t□) statistically significant (<.05) decrease in the level of active mobility and flexibility by 3.09 pts was observed, while in the experimental period (t□ - t□) the referees statistically significantly improved (<.05) by 3.82 pts. In the period between the input and output measurements (t□ - t2) no statistically significant difference was observed despite the improvement by 0.73 pts (Figure 1, Table 5).

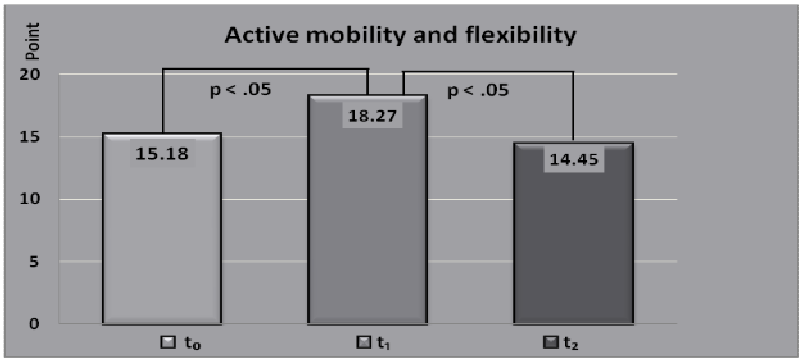


Figure 1. Assessment of active mobility and flexibility

***Evaluation of the level of passive mobility and flexibility***

In input measurement, the average value of passive mobility and flexibility was recorded on the level of -9.82 pts, while at the end of the reference period decrease in the level of the observed factors was registered (13.82 pts). After the experimental period, referees improved their passive mobility and flexibility to the level of 7.55 pts (Table 2, Table 5).

Table 2. Statistic characteristics of tests for passive mobility and flexibility

| Passive mobility and flexibility | | | |
|---|---|---|---|
| | **t0** | **t1** | **t2** |
| Arithmetic mean | 9.818 | 13.818 | 7.545 |
| Standard deviation | 4.238 | 5.016 | 2.583 |
| Median | 10.0 | 14.0 | 6.0 |
| Minimum | 6 | 6 | 6 |
| Maximum | 18 | 22 | 13 |
| Variation range | 12 | 16 | 7 |

In the reference period (t□ - t□) statistically significant (<.05) deterioration of the level of passive mobility and flexibility by 4.0 pts was observed, while in the experimental period (t□ - t□) there was statistically significant improvement (<.01) by 6.27 pts. In the period between the input and output measurements (t□ - t2) no statistically significant difference was found upon 2.27 pts improvement (Figure 2, Table 5).

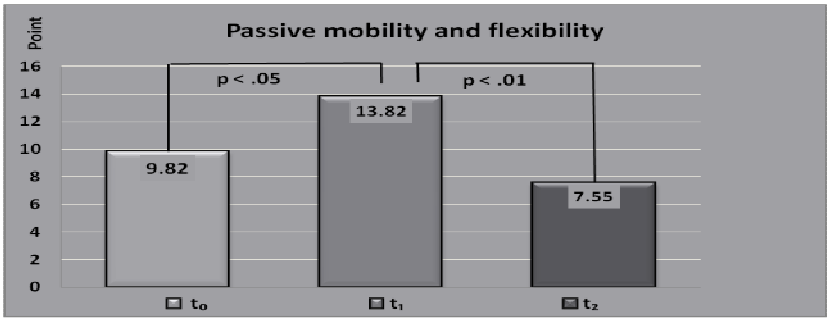


Figure 2. Assessment of passive mobility and flexibility

***Evaluation of the level of coordination and proprioception***

The average value of coordination and proprioception 4.0 pts was found at input, while at the end of the reference period the decrease (6.18 pts) was registered. After the experimental period, referees improved their coordination and proprioception to the level of 4.73 pts (Table 3).

Table 3. Statistic characteristics of tests for coordination and proprioception

| Coordination and proprioception | | | |
|---|---|---|---|
| | **t0** | **t0** | **t0** |
| Arithmetic mean | 4.0 | 6.182 | 4.727 |
| Standard deviation | 0.0 | 2.442 | 1.348 |
| Median | 4.0 | 6.0 | 4.0 |
| Minimum | 4 | 4 | 4 |
| Maximum | 4 | 10 | 8 |
| Variation range | 0 | 6 | 4 |

| Coordination and proprioception | | | |
|---|---|---|---|
| | **t0** | **t0** | **t0** |
| Arithmetic mean | 4.0 | 6.182 | 4.727 |
| Standard deviation | 0.0 | 2.442 | 1.348 |
| Median | 4.0 | 6.0 | 4.0 |
| Minimum | 4 | 4 | 4 |
| Maximum | 4 | 10 | 8 |
| Variation range | 0 | 6 | 4 |

In the reference period (t□ - t□) statistically significant deterioration of the level of coordination and proprioception (<.01) by 2.18 pts was observed, while in the experimental period (t□ - t□) no statistically significant (>.05) improvement was observed (improvement by 1.45 pts). In the period between the input and output measurements (t□ - t2) no statistically significant (>.05) improvement was found at the decrease by 0.73 pts (Figure 3, Table 5).

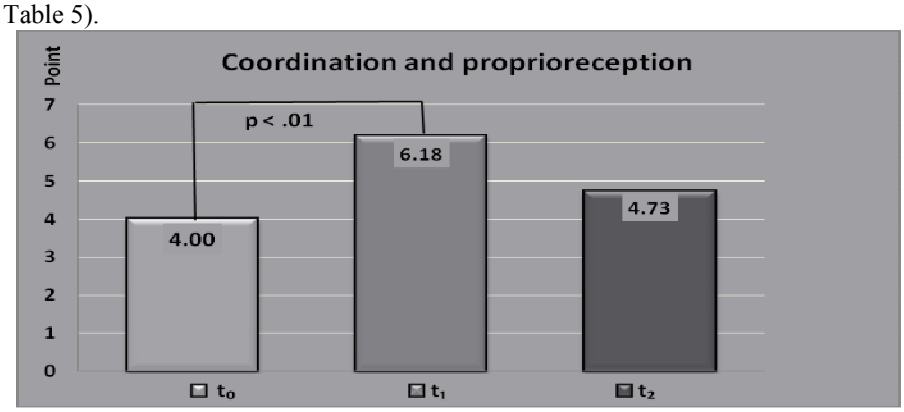


Figure 3. Assessment of coordination and proprioception

***Evaluation of the level of strength***

At input measurement average value of strength reached 4.73 pts, while at the end of the reference period we recorded deterioration to 4.91 pts (Table 4). After the experimental period, referees improved in strength to the level of 4.0 pts.

Table 4. Statistic characteristics of strength tests

| Strength | | | |
|---|---|---|---|
| | **t0** | **t1** | **t2** |
| Arithmetic mean | 4.73 | 4.909 | 4.000 |
| Standard deviation | 1.849 | 2.427 | 0.000 |
| Median | 4.0 | 4.0 | 4.0 |
| Minimum | 4 | 4 | 4 |
| Maximum | 10 | 12 | 4 |
| Variation range | 6 | 8 | 0 |

In the reference period (t□ - t□) decrease in the level of strength by 0.18 pts was recorded, which, however, was not statistically significant (>.05). In the experimental period (t□ - t□) improvement by 0.91 pts was recorded, which was not statistically significant (>.05). In the period between the input and output

measurements (t□ - t2) an improvement by 0.73 pts was recorded, which was not statistically significant (Figure 4, Table 5).

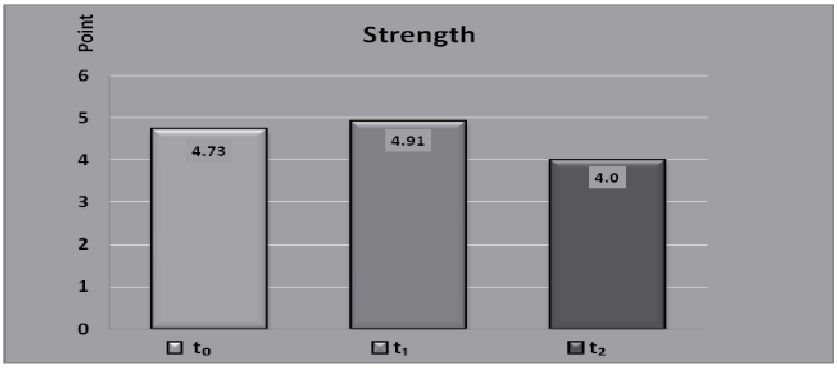


Figure 4. Assessment of strength

***Evaluation of average increments after the experimental period***

After terminating the 6-month-long experimental period we recorded the largest positive increment in the indicators „Passive mobility and flexibility" (6.27 pts) and „Active mobility and flexibility" (3.82 pts). On the contrary, the lowest increments were recorded in the indicators „Strength" (0.91 pts) and „Coordination and proprioception" (1.45 pts). In both cases of mobility and flexibility we registered statistically significant improvements (<.05), (Figure 5, Table 5).

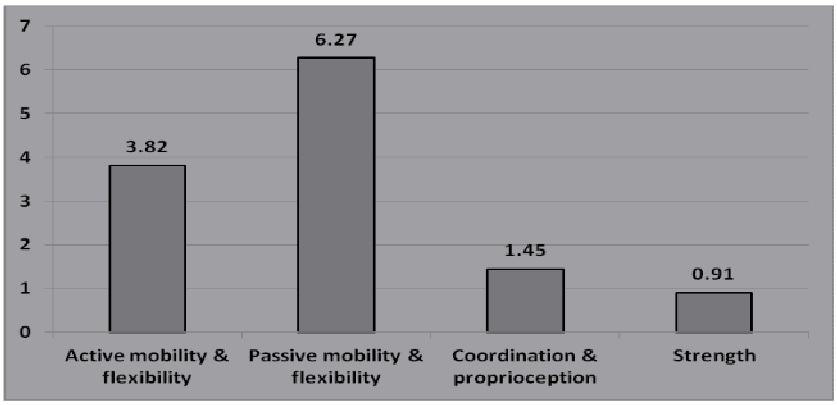


Figure 5. Average increments after the experimental period (points)

Table 5. Correlation coefficients and p-values

| Indicators | | $t_0 - t_1$ | $t_1 - t_2$ | $t_0 - t_2$ |
|---|---|---|---|---|
| Active mobility and flexibility | p - value | 0.02356 | 0.270 | 0.01593 |
| | statistical significance | P <.05 | P >.05 | P <.05 |
| Passive mobility and flexibility | p - value | .02884 | .07361 | .00109 |
| | statistical significance | P <.05 | P >.05 | P <.05 |
| Coordination and proprioception | p - value | .00710 | .05196 | .05149 |
| | statistical significance | P <.05 | P >.05 | P >.05 |
| Strength | p - value | .42271 | .11061 | .12124 |
| | statistical significance | P >.05 | P >.05 | P >.05 |

**Discussion**

Bizzini *et al.* (2009) observed incidence of injuries in 123 soccer referees (44 referees and 79 assistant referees) in the course of sport preparation for the World Championship 2006. Using a questionnaire they found the most frequent incidence of the following injuries in the course of sport career of the referees: hamstring

strain, calf strain, ankle sprain, quadriceps strain, abductor strain. There were 66 nominated referees (22 referees and 44 assistant referees) for the World Championship 2006. During the course of the championship 14 referees suffered injuries and 20 were complaining of muscular injury. Also these indicators lead Bizzini *et al.* (2014) to the realization of the specialized „Injury prevention Programme 11+". They found that if soccer training implemented the Programme 11+ at least twice a week, the rate of injuries decreased in sport training by 37% and in matches by 29%. Even higher reduction of injury risk was reported by Soligard *et al.* (2010). However, the Program 11+ is focusing on perfect performance of warm-up exercises, it does not strengthen the so-called „common frame" of the body, which is a precondition of all physical activities. And it is just the programme ComplexCore™ itself, according to Jahoda and Mitterbauer (2013), which is designed for that and which has been currently used by FIFA at the controlled sport preparation of best soccer referees in the world. Hianik (2009) realized the specialized ComplexCore™ programme with a group of female handball players, who played second men´s division in their country. After 8 weeks of realization of the programme (exercise programme was implemented 3 times a week) significant improvements (<.01) were recorded in active mobility and flexibility, in passive mobility and flexibility, in coordination and proprioception as well as in strength. It was interesting that 4 weeks after the termination of the research, when the team intentionally did not use the specialized programme ComplexCore™ in their sport training, they recorded marked decrease in the level of active mobility and flexibility. It follows that regular implementation of the specialized programme focusing on functionality of the „common frame" should be realized in regular intervals of at least three times a week.

The observed group of soccer referees of the group „Talent" recorded significant decrease (<.05) in active mobility and flexibility (-3.09 pts), in passive mobility and flexibility (-4 pts) and in coordination and proprioception (-2.18 pts) when the specialized programme was no more implemented in the reference period (27 weeks). Thus the prerequisite for more frequent incidence of injuries in the group of young talented referees was created. In the course of the following 6-month-long experimental period there came to a significant improvement (<.05) just in active mobility and flexibility (+3.82 pts) and in passive mobility and flexibility (+6.27 pts).

Based on the specialized movement of soccer referees during the match (change of physical activity every 5 seconds and frequent implementation of intensive runs from standing position) we recommend to implement (twice a week) in the sport training not only „Injury prevention programme 11+" (Bizzini *et al.*, 2014), but also specialized exercises ComplexCore™ (Jahoda and Mitterbauer, 2013), which should be realized at least three times a week. In soccer the tempo of play has been permanently increasing so the conditioning of referees should be adjusted to this trend. As a result of implementing specialized exercises the number of injuries should not increase.

## Conclusions

The aim of the study was to find out the impact of the specialized programme on the development of postural stability of soccer referees. In the reference period (27 weeks) significant worsening (<.05) of the level of active mobility and flexibility (-3.09 pts), passive mobility and flexibility (-4 pts) and in coordination and proprioception (-2.18 pts) was recorded in the observed group. The decrease in the level of strength (-0.18 pts) was not statistically significant (>.05). In the course of the following 6-month-long experimental period there came to a significant improvement (<.05) in active mobility and flexibility (+3.82 pts) and in passive mobility and flexibility (+6.27 pts). In the sphere of coordination and proprioception as well as strength no statistically significant improvement was recorded (>.05).

In order that referees avoided the increasing number of injuries we recommend realizing the specialized ComplexCore™ exercises at least three times a week. The programme should be realized with gradual increase in the requirements on performing exercises. One unit of exercises should be performed maximum for one month, then, a change of contents of exercises and demandingness should be realized. Even that it is questionable to generalize the results of our research, we can expect that under the above mentioned conditions referees would reach the most marked improvement of active and passive mobility and flexibility, thus markedly decreasing the number of injuries in a match.

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