Lower Limb Injury History in Elite Athletes: Relationship with Kinesiophobia and Effect on Physical Performance

Elit Atletlerde Alt Ekstremitelerde Yaralanma Öyküsü: Kinezyofobi ile İlişkisi ve Fiziksel Performansın Etkisi

**ABSTRACT Objective:** Considering the psychosocial factors of performance, the injury history will affect the physical performance parameters. Kinesiophobia is one of these factors. Although injuries are effective with motivation factors in athletes, the focus of research is on physical factors. Accordingly the main objective of the study was to investigate the presence of kinesiophobia in elite athletes with and without a history of lower limb injury. The secondary aim was to determine the relationship between physical performance and kinesiophobia in elite athletes. 

**Material and Methods:** The presence of a history of lower extremity injury was questioned in athletes and the time was recorded. The fear of movement was evaluated using the Tampa Scale for Kinesiophobia (TSK-17). Performance evaluations of athletes were carried out under the titles of flexibility, balance, anaerobic and aerobic tests. Obtained data were analyzed by appropriate statistical methods.

**Results:** Kinesiophobia level was different between athletes with and without a history of lower limb injuries (95%CI: 35.06 [33.41-36.71], p: 0.016). The athletes with lower limb injury history have higher kinesiophobia than athletes without lower limb injury history (p<0.05). There was a correlation between the kinesiophobia and, the history of lower limb injury of the athletes (r:0.350, p:0.015). No correlation was found in any subtittle of the physical performance tests and the history of lower limb injury (p>0.05). 

**Conclusion:** According to our study results the athletes with lower injury history have higher kinesiophobia than athletes without lower limb injury history. Kinesiophobia was related with lower limb injury history and not related with physical performance.

**Keywords:** Lower limb; kinesiophobia; athletic performance; injury


**Gereç ve Yöntemler:** Atletlerde alt ekstremitelerde yaralanma öyküsü varlığının sorgulanması ve zaman kaydedilmesi. Hareket etme korkusu, Tampa Kinezyofobi Ölçüğü (TSK-17) ile değerlendirildi. Atletlerin performans değerlendirilmesi esneklik, denge, anaerobik ve aerobik testler başlığı altında yapıldı. Elde edilen veriler uygun istatistiksel yöntemlerle analiz edildi. 

**Bulgular:** Kinezyofobi düzeyi, alt ekstremitelerde yaralanma öyküsü olan ve olmayan atletler arasında farkındı (%95 CI: 35.06 [33.41-36.71], p: 0.016). Ekstremitelerde yaralanma geçmişini olan atletler, yaralanmanın geçmişini olmayan atletlerden daha yüksek kinezyofobiye sahipti (p<0.05). Kinezyofobi alt ekstremitelerde alt ekstremitelerde yaralanma öyküsü arasında anlamlı bir ilişki vardı (r: 0.350, p: 0.015). Fiziksel performans testlerinin alt başlıklarında ve alt ekstremitelerde yaralanma öyküsü arasında anlamlı bir ilişki bulunmadı (p>0.05). 

**Sonuç:** Çalışma sonuçlarımızda göre alt ekstremitelerde yaralanma öyküsü olan elit atletlerde, kinezyofobi olmayanlara göre daha yükseksektir. Kinezyofobi alt ekstremitelerde yaralanma öyküsü ile ilişkili iken, fiziksel performansla kinezyofobi arasında ilişki gözlememişiz.
Lower limb traumas are very common with repeated movements in elite athletes and women athletes are more exposed to overuse trauma. It is seen that more than half of the injuries encountered in contact sports belongs to the lower limb. In addition to the many factors that affect performance, the injury history is one of the most changing factor. Injury related kinesiophobia could affect the rehabilitation results of athletes. In addition to the pathological changes in the musculoskeletal system, it has been reported that the trauma history may cause delay in the athlete’s time to reach high performance. Athletic performance is closely related to general health. Body composition, flexibility, balance, endurance, aerobic, and anaerobic capacity as well as motivation are parameters that affect athletic performance. The main factor in achieving the best performance in different sports is to provide physiological, anatomical and functional adaptation specific to sports. Team sports including physical contact such as basketball, American football, korfbal, volleyball are sports branches using both aerobic and anaerobic energy systems physiologically.

The physical performance tests can be used as a marker for injury history and for advanced injuries. The idea of re-injury can turn into a psychic problem by creating a fear of movement in the athlete and it affects the motivation, which is one of the performance parameters of this situation. Kinesiophobia, is defined as the vulnerability to injury, which has a negative impact on physical movement and activity. With the perception of pain, the athlete shows kinesiophobia and avoidance response. Although injury has psychosocial effects in athlete, the focus of research in literature is on physical factors. Considering the psychosocial factors of performance, it is likely that the injury history will affect the physical performance parameters.

While consistent evidence has confirmed the role of fear-avoidance responses to pain and pain-related disability measured via self-report, the influence of fear-avoidance responses on objectively assessed physical activity is less clear. In line with this information, the main objective of our study was to determine the history of lower limb injury in a university elite athlete population. Secondary aims were to investigate the presence of fear of movement between elite athletes with and without a history of lower limb injury; to investigate the relationship between physical performance, fear of movement and lower limb injury history of elite athletes.

**MATERIAL AND METHODS**

**PARTICIPANTS**

The study was approved by the local ethics committee of clinical researches of health science (date of approval: 12.03.2018, protocol number: 92). Athletes have given their informed consent for participation in the study. The research conducted in accordance with the Helsinki Declaration principles. The research sample consisted of elite athletes (volleyball, korfbal, basketball, American football players) who were trained at the university, have been licensed athletes for at least two years, and engaged in active sports in university sports clubs. The study, which was in a single center, empirical descriptive research design, was performed with forty-eight athletes (aged 21.46±3.55 years, mass 74.92±18.55 kg, height 178.92±8.97 cm; body mass index, 23.32±4.57 kg/m², mean±standard deviation, SD). Seven athletes (14.6%) were korfbal players, 10 of them (20%) were basketball players, 14 of them (29.2), American football players, and 17 of them (35.4%) were volleyball players.

The definition of injury was explained as athletes’ dislocation in the lower limb, ligament rupture, fracture, strain or contusion. Lower limb injury history (LLIH) was assessed with “yes” or “no” question. A minimum of three months and no more than 12 months after the history of injury in the lower limb, age range 18-35 (years), two days in a week and two hours per day in a training program were determined as inclusion criteria. Athletes who met these criteria were included in the study. Two or multiple lower limb trauma history (with more than one injury), presence of an unusual feature in nutrition regime and lifestyle, presence of any systemic health problems were determined as the exclusion criteria. Twenty-one athletes who did not meet the inclusion criteria were excluded from the study.

The presence of a history of lower limb injury during the recent 3-12 months was determined. Time and area of injury were recorded. Of the 48 athletes
evaluated, 25 (52.1%) had a history of lower limb injury, while 23 (47.9%) had no injury history. The mean duration of the injury history was 5.24 month (min: 3-max: 8 month). Age, gender, dominant limb of the athletes were questioned. Twenty-five of the participants were female (52.08%) and 23 (47.92%) were male. Forty-one athletes were right dominant (%85.4), while 7 (14.6%) athletes were left dominant. Weight and body compositions of the athletes were measured with TANITA Bioimpedance Body Composition Analyzer.13 Height was measured using a stadiometer with a precision level of 0.01 cm. Body mass index with height and body weight (BMI, kg/m²) was calculated.

KINESIOPHOBIA EVALUATION
The kinesiophobia was evaluated using the Tampa Scale of Kinesiophobia (TSK-17). The validity and reliability of the scale was performed by Yilmaz et al.14 There is a 4-point likert scoring in the scale. The total score ranges between 17 and 68.10 A high value on the TSK-17 indicates a high degree of kinesiophobia and a cut-off score was developed by Vlaeyen et al., where a score of 37 or over is considered a high score.15

PERFORMANCE EVALUATIONS
The hamstring muscles flexibility was evaluated with the Sit and Reach Flexibility Test platform.16 The athletes were asked to push the metal bar on the upper surface of the platform with hand finger tips, shoeless, soles on the tip of platform and knees were fixed on the ground. The point reached by the metal bar was recorded in cm. After resting for 20 seconds, the same procedure was repeated. The best value was determined as the level of flexibility.

Static balance was evaluated by using the Flamingo Balance Test. Athletes tried to stay in balance for one minute on a wood balancing equipment that is 50 cm long, 4 cm high and 3 cm wide. The time was stopped when the balance deteriorated. When the athlete regained his balance by going to the balancing equipment, the time was continued from where it left off. The athlete’s every balancing attempt was counted and this number was recorded as a test score.17

Endurance assessments of the athletes were made by recording the numbers of push-ups and sit-ups they could do for 60 sec.18 Repetitions in the correct technique were recorded. A five minute break was given between each test.

The measurement of the explosive power in the anaerobic tests was evaluated by vertical jump and standing long jump tests. During the Vertical Jump Test, which measures the explosive power in the vertical direction, the athlete was standing equal to the weight of both feet open at the shoulder width and the starting distance value was recorded after reaching as high as possible. The farthest distance that he/she could reach was marked. The vertical distance between the two marked points was taken as score.19

The agility was evaluated with Slalom Test. In the Slalom Test, six hurdles were placed in the space at two meter intervals. The individual was asked to run at the maximum speed in the slalom pattern between hurdles in both forward and reverse directions. The start time of the foot was first started and the time until the same line was passed was recorded. The normative values of the test are used as base.20 The athletes were asked to pass the distance marked in the 20-meter Sprint Speed Test as soon as possible. After the evaluation repeated twice, the best time was recorded.21

Aerobic capacities of the athletes were evaluated with 12-minute Running Test. In the test, the person was told to run for 12 minutes in the marked area as much distance as possible within 12 minutes. As soon as the person started to run, the stopwatch was started and the distance at the end of 12 minutes was recorded. Maximal oxygen consumption was calculated using the formula

$$\dot{V}O_{2\text{peak}} (\text{ml \cdot min}^{-1} \cdot \text{kg}^{-1}) = (\text{covered distance (m)} - 504.9) .$$

All evaluations were carried out by blinded researchers in the same standard ambient conditions with adequate break period between tests.

STATISTICAL ANALYSIS
According to the likert coding in the TSK-17 questionnaire, total score was calculated. Mann Whitney U test was used to compare the independent variables. Pearson Correlation Test was used to analyse the normally distributed variables. Spearman Correlation Test was used for the relationship analyses for nonparametric distributions. Statistical significance level was taken as 0.05 in all analyses. Normality control was performed with Shapiro Wilk test. De-
scriptive statistics were expressed as mean, standard deviation, and percentages. Statistical analysis was performed using the Statistical Package for Social Sciences version 22.0 (IBM) software program.

## RESULTS

Variable differences in physical performance of the athletes with and without injury history were shown in Table 1. Differences between kinesiophobia of the athletes with and without injury history were shown in Table 1.

In athletes with a lower limb injury history (LLIH), kinesiophobia were higher than those without an injury history (p<0.05) (Table 2).

### TABLE 1: Physical performance and kinesiophobia results of the athletes.

<table>
<thead>
<tr>
<th></th>
<th>LLIH (n=25)</th>
<th>noLLIH (n=23)</th>
<th>Total (n=48)</th>
<th>Confidence Interval</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X±SD</td>
<td>X±SD</td>
<td>X±SD</td>
<td>%95 CI</td>
<td></td>
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<tr>
<td>Flexibility</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sit and Reach Test (cm)</td>
<td>26.60±10.55</td>
<td>30.83±10.72</td>
<td>28.62±10.73</td>
<td>(25.59, 31.85)</td>
<td>0.193</td>
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<tr>
<td>Balance</td>
<td></td>
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<tr>
<td>Flamingo Balance Test</td>
<td></td>
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</tr>
<tr>
<td>Right Foot (n/min)</td>
<td>5.92±4.536</td>
<td>4.57±4.262</td>
<td>5.27±4.41</td>
<td>(4.02, 6.52)</td>
<td>0.293</td>
</tr>
<tr>
<td>Left Foot (n/min)</td>
<td>5.84±4.497</td>
<td>6.04±3.808</td>
<td>5.94±4.13</td>
<td>(4.77, 7.11)</td>
<td>0.867</td>
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<tr>
<td>Endurance</td>
<td></td>
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<tr>
<td>Sit-up Test (n)</td>
<td>24.83±10.25</td>
<td>27.72±7.46</td>
<td>25.77±7.68</td>
<td>(22.32, 27.22)</td>
<td>0.772</td>
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<tr>
<td>Push-up Test (n)</td>
<td>24.88±15.6</td>
<td>33.35±15.35</td>
<td>28.94±15.90</td>
<td>(24.44, 33.44)</td>
<td>0.770</td>
</tr>
<tr>
<td>Aerobic Performance</td>
<td></td>
<td></td>
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<tr>
<td>VO2peak (ml · min⁻¹ · kg⁻¹) = (covered distance (m) - 504.9)</td>
<td>32.36±6.31</td>
<td>30.50±5.75</td>
<td>31.39±6.04</td>
<td>(29.68, 33.1)</td>
<td>0.433</td>
</tr>
<tr>
<td>Anaerobic Performance</td>
<td></td>
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<tr>
<td>Power</td>
<td></td>
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<tr>
<td>Vertical Jump Test (cm)</td>
<td>41.30±12.26</td>
<td>44.74±38.83</td>
<td>43.09±29.04</td>
<td>(34.88, 51.3)</td>
<td>0.877</td>
</tr>
<tr>
<td>Long Jump Test (cm)</td>
<td>199.67±41.83</td>
<td>201.68±29.56</td>
<td>200.72±35.47</td>
<td>(190.7, 210.75)</td>
<td>0.877</td>
</tr>
<tr>
<td>Speed-agility</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Slalom Test (sec)</td>
<td>14.95±1.529</td>
<td>14.90±1.501</td>
<td>14.92±1.50</td>
<td>(14.30, 15.14)</td>
<td>0.959</td>
</tr>
<tr>
<td>Kinesiophobia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSK-17 (score)</td>
<td>37.16±4.79</td>
<td>32.78±6.09</td>
<td>35.06±5.83</td>
<td>(33.41, 36.71)</td>
<td>0.016</td>
</tr>
</tbody>
</table>

LLIH: Athletes with a lower limb injury history, noLLIH: Athletes without lower limb injury history, X: Mean, SD: Standard deviation, n: Number, VO2 peak: Maximal oxygen consumption, TSK-17: Tampa Scale of Kinesiophobia, pa: Significance level of Mann Whitney U Test.

### TABLE 2: The correlations results between the kinesiophobia and the LLIH with physical performance of the athletes.

<table>
<thead>
<tr>
<th></th>
<th>Kinesiophobia of Athletes</th>
<th>LLIH</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>rho</td>
<td>p*</td>
<td>n</td>
</tr>
<tr>
<td>Flamingo Balance Test</td>
<td>48</td>
<td>-0.059</td>
<td>0.693</td>
<td>-0.162</td>
</tr>
<tr>
<td>Right Foot (n/min)</td>
<td>-</td>
<td>0.001</td>
<td>0.996</td>
<td>0.060</td>
</tr>
<tr>
<td>Flamingo Balance Test</td>
<td>48</td>
<td>-0.192</td>
<td>0.191</td>
<td>0.032</td>
</tr>
<tr>
<td>Left Foot (n/min)</td>
<td>-</td>
<td>-0.136</td>
<td>0.357</td>
<td>0.879</td>
</tr>
<tr>
<td>Slalom Test (sec)</td>
<td>0.090</td>
<td>0.544</td>
<td>-0.008</td>
<td>0.960</td>
</tr>
<tr>
<td>Sit and Reach Test (cm)</td>
<td>-0.019</td>
<td>0.886</td>
<td>0.190</td>
<td>0.196</td>
</tr>
<tr>
<td>Sit-up Test (n)</td>
<td>-0.138</td>
<td>0.350</td>
<td>-0.042</td>
<td>0.776</td>
</tr>
<tr>
<td>Push-up Test (n)</td>
<td>-0.223</td>
<td>0.128</td>
<td>0.258</td>
<td>0.077</td>
</tr>
<tr>
<td>VO2peak (ml · min⁻¹ · kg⁻¹) = (covered distance (m) - 504.9)</td>
<td>-0.029</td>
<td>0.847</td>
<td>0.114</td>
<td>0.439</td>
</tr>
<tr>
<td>Long Jump Test (cm)</td>
<td>-0.080</td>
<td>0.590</td>
<td>-0.023</td>
<td>0.879</td>
</tr>
</tbody>
</table>

LLIH: Athletes with a lower limb injury history, n: Number, TSK-17: Tampa Scale of Kinesiophobia, VO2 peak: Maximal oxygen consumption, p* -rho: Sperman correlation coefficient, p: Statistically significance level.
The correlation results between kinesiophobia and the LLIH with physical performance of athletes were shown in Figure 1.

No correlation was found in subtitles of the physical performance tests and history of lower limb injury (p>0.05). Also, there was no correlation between the kinesiophobia of athletes and the subtitles of the physical performance tests.

The correlation results between the kinesiophobia and the LLIH was shown in Figure 1. There was a correlation between the LLIH of the athletes and kinesiophobia (rho: 0.350, p: 0.015). The correlation was significant but small.

DISCUSSION

Based on the most important result print-outs of the study revealed that kinesiophobia was related with lower limb injury history and not related to physical performance. The athletes with lower limb injury history have higher kinesiophobia than athletes without lower limb injury history.

There are two models that describe the behavior of people with the fear of movement. The fear-avoidance model which states that people who feel pain, or who have had an injury often avoid the referred activity.23 However in light that athletes and even ill people, such as low back pain patients maintain their level of activity and the performance level, another model has been emerging, the avoidance-endurance model. This avoidance-endurance model states that these people may avoid some specific activity but find strategies to maintain their functional state even with high levels of fear.11 According to our research results we could comment that the kinesiophobia or the history of lower limb injury not always affect the physical performance. This could be the reason that athletes develop certain strategies and maintain their performance levels in line with this avoidance-endurance model. On the other hand, the kinesiophobia due to a limited interval in the duration of injury may not have affected the physical performance of athletes. It was also interesting that there were no differences in flexibility as well as the performance of the athletes. Flexibility and balance were the parameters at the center of conditional capabilities and were the basis of the performance.24 Lisman et al. reported that flexibility was reduced and a decrease in balance performance was observed in individuals with a history of lower limb injury. However, Hennessey et al. showed that there was no change in flexibility with an injury history.25 In addition to the limited number of studies on the relationship between the lower limb injury history and physical performance variables in athletes, the flexibility and the balance parameters in our study did not show any difference between the athletes with and without a history of lower limb injury. And also no relation was found between aerobic or anaerobic titles of performance tests in evaluated athletes. The reason for these results may be the duration of the injury or the fact that the athletes have involved and received a good intensive rehabilitation. Although athletes have a history of injury, they may have achieved adequate improvement in flexibility, balance and performance parameters.

Hsu et al. reported that training information related to the principles of psychology needs to be included in the rehabilitation program of athletes after the injury and this way the rehabilitation results can be improved in athletes with high kinesiophobia.26 In our study, although the average duration of the time passed after injury was five months, it was observed
that the kinesiophobia continued. Noehren et al. reported that, after injury, athletes carry less weight to the injured lower limb and mention a strong relationship between an injury history and kinesiophobia. Tichonova et al. reported that kinesiophobia developed after anterior cruciate ligament reconstruction and that athletes had more difficulty in daily activities. It has been reported by the authors that there was a relation between the poor quality of life before and after rehabilitation practices and high level kinesiophobia. In the literature, it was observed that kinesiophobia was the most frequently evaluated after anterior cruciate ligament injury in sports-related injuries. It has been reported that kinesiophobia was associated with possible re-injury following anterior cruciate ligament injury continued in athletes even after one year and adversely affected their performance. In high school footballers, it has been reported that the injury history only creates a difference in aerobic capacity. In the research outputs that examined the effect of lower limb injuries on aerobic exercise capacity, anaerobic power and isokinetic muscle strength in the muscles around the knee. Similarly with the literature, there was a correlation between injury history and kinesiophobia in our study. After sports injury, positive psychological effects on return to sports have very strong effects and along with this, it was stated that psychological evaluation in rehabilitation and training processes and approaches to be taken into consideration by clinicians. In the light of our study results and literature, we may state that there is no clarity about kinesiophobia and physical performance and further research should be done.

CONCLUSION

According to our study results, the strength of our study is that we give an example of avoidance-endurance model in a research. It is a limitation of our study that we could not make the assessments in a single sports brand. Another limitation was that the athletes have not had a follow-up during the injury period and the rehabilitation processes. In further research, the performance of lower limb injury can be questioned in relation to kinesiophobia in the rehabilitation process. Kinesiophobia should not be ignored by clinicians who are conducting research to improve sports performance. The results of this research encourage clinicians to consider kinesiophobia in their preliminary assessment. Under the light of our study results and literature, we may state that there is no clarity about kinesiophobia and physical performance and further research should be done.

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connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and/or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Tülay Çevik Saldiran, Emine Atç; Design: Tülay Çevik Saldiran, Barcu Yeşilkaya; Control/Supervision: Tülay Çevik Saldiran, Emine Atç; Data Collection and/or Processing: Ahmet Cüneyt Akgöl, Bedriye Güler; Analysis and/or Interpretation: Mehmet Örkeskin, Özgül Öztürk; Literature Review: Gamze Aydin, Tülay Çevik Saldiran, Laçin Naz Taşcılar; Writing the Article: Tülay Çevik Saldiran, Özgül Öztürk, Emine Atç; Critical Review: Emine Atç, Ahmet Cüneyt Akgöl, Tülay Çevik Saldiran.

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