ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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

Elit Atletlerde Alt Ekstremite Yaralanma Öyküsü: Kinezyofobi ile İlişkisi ve Fiziksel Performans Üzerindeki Etkisi

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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 of 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 to 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 subtitle 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 limb 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

ÖZET Amaç: Performansın psikososyal faktörleri göz önüne alındığında, yaralanma geçmişinin fiziksel performans parametrelerini etkilemesi muhtemeldir. Kinezyofobi de bu faktörlerden birisidir. Yaralanmalar atletlerde motivasyon faktörü ile etkili olsa da, araştırmaların odak noktası fiziksel etmenlerdir. Bu doğrultuda çalışmanın birincil amacı, alt ekstremite yaralanması öyküsü olan ve olmayan elit atletler arasındaki kinezyofobi varlığını araştırmaktı. İkincil amaç ise elit atletlerde fiziksel performans ile kinezyofobi arasındaki ilişkiyi belirlemekti. **Gereç ve Yöntemler:** Atletlerde alt ekstremite yaralanma öyküsü varlığı sorgulandı ve zamanı kaydedildi. Hareket etme korkusu, Tampa Kinezyofobi Ölçeği (TSK-17) ile değerlendirildi. Atletlerin performans değerlendirmeleri esneklik, denge, anaerobik ve aerobik testler başlığı altında yapıldı. Elde edilen veriler uygun istatistiksel yöntemlerle analiz edildi. **Bulgular:** Kinezyofobi düzeyi, alt ekstremite yaralanması öyküsü olan ve olmayan atletler arasında farklıydı (%95 CI: 35.06 [33.41-36.71], p: 0.016). Ekstremite yaralanma geçmişi olan atletler, yaralanma geçmişi olmayan atletlerden daha yüksek kinezyofobiye sahipti ($p<0.05$). Kinezyofobi ile atletlerin alt ekstremite yaralanma öyküsü arasında anlamlı bir ilişki vardı (r: 0.350, p: 0.015). Fiziksel performans testlerinin alt başlıkları ile alt ekstremite yaralanma öyküsü arasında anlamlı bir ilişki bulunmadı ($p>0.05$). **Sonuç:** Çalışma sonuçlarımıza göre alt ekstremitede yaralanma öyküsü olan elit atletlerde, kinezyofobi olmayanlara göre daha yüksekti. Kinezyofobi alt ekstremite yaralanma öyküsü ile ilişkili iken, fiziksel performansla kinezyofobi arasında ilişki gözlenmedi.

Anahtar Kelimeler: Alt ekstremite; kinezyofobi; sporcu performansı; yaralanma

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Lower limb traumas are very common with repeated movements in elite athletes and women athletes are more exposed to overuse trauma.[1] It is seen that more than half of the injuries encountered in contact sports belongs to the lower limb.[2,3] In addition to the many factors that affect performance, the injury history is one of the most changing factor.[4] Injury related kinesiophobia could affect the rehabilitation results of athletes.[5] 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.[4,6] 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.[7] The main factor in achieving the best performance in different sports is to provide physiological, anatomical and functional adaptation specific to sports.[7,8] Team sports including physical contact such as basketball, American football, korfball, volleyball are sports branches using both aerobic and anaerobic energy systems physiologically.[8]

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.[9] Kinesiophobia, is defined as the vulnerability to injury, which has a negative impact on physical movement and activity.[10] 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.[7] 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.[11] 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, korfball, 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.[12] 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/m^2, mean±standard deviation, SD). Seven athletes (14.6%) were korfball 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.[2] 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, a single region injury history in 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.[5] 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/m^2) 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 Yılmaz 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 $\dot{V}O_{2peak}$ (ml $\cdot$ min^{-1} $\cdot$kg^{-1}) = (covered distance (m) - 504.9).[22] 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 distrubuted variables. Spearman Correlation Test was used for the relationship analyses for nonparametric distrubutions. 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.

	LLIH (n=25) X±SD	noLLIH (n=23) X±SD	Total (n=48) X±SD	Confidence Interval %95 CI	p[a]
Flexibility					
Sit and Reach Test (cm)	26.60±10.55	30.83±10.72	28.62±10.73	(25.59, 31.65)	0.193
Balance					
Flamingo Balance Test					
Right Foot (n/min)	5.92±4.536	4.57±4.262	5.27±4.41	(4.02, 6.52)	0.293
Flamingo Balance Test					
Left Foot (n/min)	5.84±4.497	6.04±3.808	5.94±4.13	(4.77, 7.11)	0.867
Endurance					
Sit-up Test (n)	24.83±10.25	27.72±7.16	24.77±8.68	(22.32, 27.22)	0.772
Push-up Test (n)	24.88±15.6	33.35±15.35	28.94±15.90	(24.44, 33.44)	0.770
Aerobic Performance					
$\dot{V}O_{2peak}$ (ml · min^{-1} ·kg^{-1}) = (covered distance (m) - 504.9)	32.36±6.31	30.50±5.75	31.39±6.04	(29.68, 33.1)	0.433
Anaerobic Performance					
Power					
Vertical Jump Test (cm)	41.30±12.26	44.74±38.83	43.09±29.04	(34.88, 51.3)	0.687
Long Jump Test (cm)	199.67±41.63	201.68±29.56	200.72±35.47	(190.7, 210.75)	0.877
Speed-agility					
Slalom Test (sec)	14.95±1.529	14.90±1.501	14.72±1.50	(14.30, 15.14)	0.959
Kinesiophobia					
TSK-17 (score)	37.16±4.79	32.78±6.09	35.06±5.83	(33.41, 36.71)	0.016

LLIH: Athletes with a lower limb injury history, noLLIH: Athletes without lower limb injury history, X: Mean, SD: Standard deviation, n: Number, VO^2 pic: 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.

	Kinesiophobia of Athletes			LLIH	
	n	rho	p*	rho	p*
Flamingo Balance Test Right Foot (n/min)	48	-0.059	0.693	-0.162	0.271
Flamingo Balance Test Left Foot (n/min)	-	0.001	0.996	0.060	0.683
Vertical Jump Test (cm)		-0.192	0.191	0.032	0.831
Vertical Jump Test (cm)		-0.136	0.357	0.879	0.143
Slalom Test (sec)		0.090	0.544	-0.008	0.960
		r	p	r	p
Sit and Reach Test (cm)		-0.019	0.896	0.190	0.196
Sit-up Test (n)		-0.138	0.350	-0.042	0.776
Push-up Test (n)		-0.223	0.128	0.258	0.077
$\dot{V}O_{2peak}$ (ml · min^{-1} ·kg^{-1}) = (covered distance (m) - 504.9)		-0.029	0.847	0.114	0.439
Long Jump Test (cm)		-0.080	0.590	-0.023	0.879

LLIH: Athletes with a lower limb injury history, n: Number, TSK-17: Tampa Scale of Kinesiophobia, VO^2 pic: Maximal oxygen consumption, p* -rho: Sperman correlation cofficient, p-r: Pearson correlation cofficient, p: Statistically significance level.

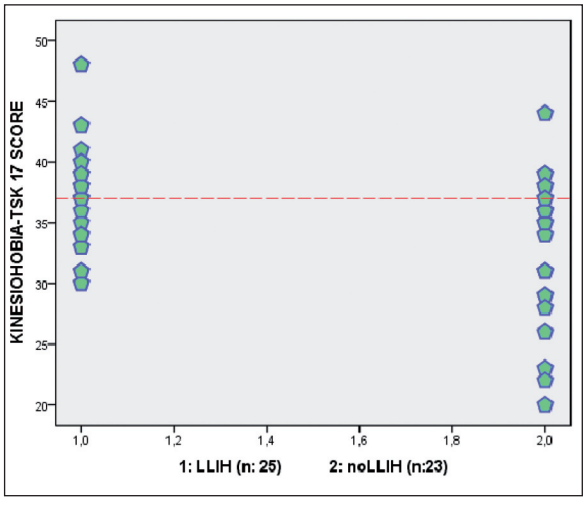

FIGURE 1: The correlation results between kinesiophobia and the LLIH. Figure 1 shows that the athletes with lower limb injury history (1) have higher kinesiophobia than the athletes without lower limb injury history (2). LLIH: Athletes with a lower limb injury history. noLLIH: Athletes without lower limb injury history. Fit line (- - -) inserted for TSK-17 cut-off point (Score: 37).

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.[7,9] 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.[24] 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.[27] 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.[28] In the literature, it was observed that kinesiophobia was the most frequently evaluated after anterior cruciate ligament injury in sports-related injuries.[26-29] 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.[29] 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.[30] 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.[31] In the light of our study results and the literature, we may state that, the history of an injury creates a higher level of kinesiophobia. The implication of our study to clinical practice was that athletes with a history of injury should be questioned about kinesiophobia.

Different demographic and anthropometric results have been observed in different subgroups of contact sports, in the literature. Compared to research conducted in the university elite athletes, while the gender variable and Hootman et al.'s study data were similar and it was different from the results of the epidemiological research conducted by Yang et al.[2,3] It has been reported that body composition is one of the main factors affecting performance and it is among the risk factors that can cause injury.[32] In our study, it was observed that body composition results were similar to the studies in the literature and athletes were in the ideal range in terms of body composition variables in the anthropometry title. In line with this, another reason why performances of athletes were not affected by the history of injury and fear of movement may be that they had an ideal body composition.

According to our research 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.

CONCLUSION

According to our study results, the athletes with lower limb injury history have higher kinesiophobia than the athletes without lower limb injury history. Kinesiophobia was related with lower limb injury history and not related with physical performance. Although a history of lower limb injury is the cause of fear of movement, we could not always say that this will affect performance in elite athletes.

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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 Saldıran, Emine Atıcı;* ***Design:*** *Tülay Çevik Saldıran, Burcu Yeşilkaya;* ***Control/Supervision:*** *Tülay Çevik Saldıran, Emine Atıcı;* ***Data Collection and/or Processing:*** *Ahmet Cüneyt Akgöl, Bedriye Güler;* ***Analysis and/or Interpretation:*** *Mehmet Özkeskin, Özgül Öztürk;* ***Literature Review:*** *Gamze Aydın, Tülay Çevik Saldıran, Laçin Naz Taşçılar;* ***Writing the Article:*** *Tülay Çevik Saldıran, Özgül Öztürk, Emine Atıcı;* ***Critical Review:*** *Emine Atıcı, Ahmet Cüneyt Akgöl, Tülay Çevik Saldıran.*

REFERENCES

1. Emery CA, Meeuwisse WH, McAllister JR. Survey of sport participation and sport injury in Calgary and area high schools. Clin J Sport Med. 2006;16(1):20-6. [Crossref] [PubMed]
2. Yang J, Tibbetts AS, Covassin T, Cheng G, Nayar S, Heiden E. Epidemiology of overuse and acute injuries among competitive collegiate athletes. J Athl Train. 2012;47(2):198-204. [Crossref] [PubMed] [PMC]
3. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. J Athl Train. 2007;42(2):311-9. [PubMed]
4. Gabbett TJ. The training-injury prevention paradox: should athletes be training smarter and harder? Br J Sports Med. 2016;50(5):273-80. [Crossref] [PubMed] [PMC]
5. Lentz TA, Zeppieri G Jr, George SZ, Tillman SM, Moser MW, Farmer KW, et al. Comparison of physical impairment, functional, and psychosocial measures based on fear of reinjury/lack of confidence and return-to-sport status after ACL reconstruction. Am J Sports Med. 2015;43(2):345-53. [Crossref] [PubMed]
6. Feigenbaum LA, Baraga M, Kaplan LD, Roach KE, Calpino KM, Dorsey K, et al. Return to sport following surgery for a complicated tibia and fibula fracture in a collegiate women's soccer player with a low level of kinesiophobia. Int J Sports Phys Ther. 2015;10(1):95-103. [PubMed]
7. Bayraktar B, Kurtoğlu M. [Performance in sports, effective factors, evaluation and enhancement]. Klinik Gelişim. 2009;22(1):16-24.
8. McArdle WD, Katch FI, Katch VL. Exercise Physiology: Nutrition, Energy, and Human Performance. 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2010. p.134-66.
9. Hegedus EJ, McDonough S, Bleakley C, Baxter GD, DePew JT, Bradbury I, et al. Physical performance tests predict injury in National Collegiate Athletic Association athletes: a three-season prospective cohort study. Br J Sports Med. 2016;50(21):1333-7. [Crossref] [PubMed]
10. Bränström H, Fahlström M. Kinesiophobia in patients with chronic musculoskeletal pain: differences between men and women. J Rehabil Med. 2008;40(5):375-80. [Crossref] [PubMed]
11. Hasenbring MI, Verbunt JA. Fear-avoidance and endurance-related responses to pain: new models of behavior and their consequences for clinical practice. Clin J Pain. 2010;26(9):747-53. [Crossref] [PubMed]
12. Swann C, Moran A, Piggott D. Defining elite athletes: issues in the study of expert performance in sport psychology. Psychol Sport Exerc. 2015;16:3-14. [Crossref]
13. Kyle UG, Bosaeus I, De Lorenzo AD, Deurenberg P, Elia M, Gómez JM, et al. Bioelectrical impedance analysis--part I: review of principles and methods. Clin Nutr. 2004;23(5):1226-43. [PubMed]
14. Yilmaz ÖT, Yakut Y, Uygur F, Uluğ N. [Turkish version of the Tampa Scale for Kinesiophobia and its test-retest reliability]. Fizyoterapi Rehabilitasyon. 2011;22(1):44-9.
15. Vlaeyen JW, Kole-Snijders AM, Rotteveel AM, Ruesink R, Heuts PH. The role of fear of movement/(re) injury in pain disability. J Occup Rehabil. 1995;5(4):235-52. [Crossref] [PubMed]
16. Mayorga-Vega D, Merino-Marban R, Viciana J. Criterion-related validity of sit-and-reach tests for estimating hamstring and lumbar extensibility: a meta-analysis. J Sports Sci Med. 2014;13(1):1-14. [Crossref] [PubMed]
17. Hrysomallis C. Relationship between balance ability, training and sports injury risk. Sports Med. 2007;37(6):547-56. [Crossref] [PubMed]
18. Vaara JP, Kyröläinen H, Niemi J, Ohrankämmen O, Häkkinen A, Kocay S, et al. Associations of maximal strength and muscular endurance test scores with cardiorespiratory fitness and body composition. J Strength Cond Res. 2012;26(8):2078-86. [Crossref] [PubMed]
19. Patterson DD, Peterson DF. Vertical jump and leg power norms for young adults. Meas Phys Educ Exerc Sci. 2004;8(1):33-41. [Crossref]
20. Alricsson M, Harms-Ringdahl K, Werner S. Reliability of sports related functional tests with emphasis on speed and agility in young athletes. Scand J Med Sci Sports. 2001;11(4):229-32. [Crossref] [PubMed]
21. Comfort P, Bullock N, Pearson SJ. A comparison of maximal squat strength and 5-, 10-, and 20-meter sprint times, in athletes and recreationally trained men. J Strength Cond Res. 2012;26(4):937-40. [Crossref] [PubMed]
22. Saritaş N, Uyanik F, Hamurcu Z. Effects of acute twelve minute run test on oxidative stress and antioxidant enzyme activities. Afr J Pharm Pharmacol. 2011;5(9):1218-22. [Crossref]
23. Noehren B, Kline P, Ireland ML, Johnson DL. Kinesiophobia is strongly associated with altered loading after an ACL reconstruction: implications for re-injury risk. Orthop J Sports Med. 2017;5(7 Suppl 6):2325967117S00323. [Crossref] [PMC]
24. Tichonova A, Rimdeikienė I, Petruševičienė D, Lendraitienė E. The relationship between pain catastrophizing, kinesiophobia and subjective knee function during rehabilitation following anterior cruciate ligament reconstruction and meniscectomy: a pilot study. Medicina (Kaunas). 2016;52(4):229-37. [Crossref] [PubMed]
25. Luque-Suarez A, Martinez-Calderon J, Falla D. Role of kinesiophobia on pain, disability and quality of life in people suffering from chronic musculoskeletal pain: a systematic review. Br J Sports Med. 2019;53(9):554-9. [Crossref] [PubMed]
26. Ardern CL, Taylor NF, Feller JA, Webster KE. A systematic review of the psychological factors associated with returning to sport following injury. Br J Sports Med. 2013;47(17):1120-6. [Crossref] [PubMed]
27. Hsu CJ, Meierbachtol A, George SZ, Chmielewski TL. Fear of reinjury in athletes. Sports Health. 2017;9(2):162-7. [Crossref] [PubMed] [PMC]

28. Tripp DA, Stanish W, Ebel Lam A, Brewer BW, Birchard J. Fear of reinjury, negative affect, and catastrophizing predicting return to sport in recreational athletes with anterior cruciate ligament injuries at 1 year postsurgery. Rehabilitation Psychology. 2007;52(1):74. [Crossref]

29. Ko KJ, Ha GC, Kim DW, Kang SJ. Effects of lower extremity injuries on aerobic exercise capacity, anaerobic power, and knee isokinetic muscular function in high school soccer players. J Phys Ther Sci. 2017;29(10):1715-9. [Crossref] [PubMed] [PMC]

30. de la Motte SJ, Lisman P, Gribbin TC, Murphy K, Deuster P. A systematic review of the association between physical fitness and musculoskeletal injury risk: part 3-flexibility, power, speed, balance, and agility. J Strength Cond Res. 2019;33(6):1723-35. [Crossref] [PubMed]

31. Hennessey L, Watson AW. Flexibility and posture assessment in relation to hamstring injury. Br J Sports Med. 1993;27(4):243-6. [Crossref] [PubMed] [PMC]

32. Ezzat AM, Schneeberg A, Koehoorn M, Emery CA. Association between body composition and sport injury in Canadian adolescents. Physiother Can. 2016;68(3):275-81. [Crossref] [PubMed] [PMC]