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A COMPARISON OF INJURY RISK SCREENING TOOLS IN TURKISH YOUNG ELITE MALE HANDBALL PLAYERS BASED ON FIELD POSITIONS

ORIGINAL ARTICLE

ABSTRACT

Purpose: Handball is one of the team sports that common injuries reported. Movement analyses and detecting functionally limited areas have been of utmost importance for eliminating injury risks. This study aimed to determine the injury risks and compare them according to field positions in young Turkish elite male handball players.

Methods: Fifty-four players (age=15.69±0.47 years, height=182.80±6.53 cm, weight=82.09±14.28 kg, body mass index=24.52±3.77 kg/m^2) who were invited to the U17 National Handball Team participated in the study. Descriptive data with physical characteristics were obtained. Injury risk was assessed using the Functional Movement Screen (FMS) test, Y-Balance Test (YBT)-Upper Extremity, and YBT-Lower Extremity tests. The overall scores for FMS, YBT-Upper Extremity, and YBT-Lower Extremity were calculated for all subjects.

Results: The field positions were distributed as goalkeepers (n=7), back players (n=24), wing players (n=13), and pivots (n=10). Based on the field positions, pivots and goalkeepers were determined as having the lowest scores regarding FMS and YBT-Upper Extremity ($p<0.05$).

Conclusion: Players who compete in the positions of goalkeeper and pivot might have higher injury risk due to lower FMS and YBT-Upper Extremity scores. These results would allow the trainers and players to observe the current status and to implement the injury prevention programs.

Key Words: Athletes; Injury; Risk Assessment; Sports.

TÜRK GENÇ ELİT ERKEK HENTBOL OYUNCULARINDA YARALANMA RİSKİ TARAMA ÖLÇÜMLERİNİN SAHA İÇİ POZİSYONLARA GÖRE KARŞILAŞTIRILMASI

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Hentbol, en sık yaralanma belirtilen takım sporlarından biridir. Hareket analizleri ve fonksiyonel olarak sınırlı alanları tespit etmek, yaralanma risklerini ortadan kaldırmak için son derece önemlidir. Bu çalışmada genç Türk elit erkek hentbol oyuncularında yaralanma risklerinin belirlenmesi ve sahadaki pozisyonlara göre karşılaştırılması amaçlandı.

Yöntem: Araştırmaya, U17 Milli Hentbol Takımı'na davet edilen 54 oyuncu (yaş=15,69±0,47 yıl, boy=182,80±6,53 cm, vücut ağırlığı=82,09±14,28 kg, vücut kütle indeksi=24,52±3,77 kg/m^2) katıldı. Fiziksel özelliklerden tanımlayıcı veriler elde edildi. Yaralanma riski, Fonksiyonel Hareket Analizi (FHA) testi, Y Denge Testi (YDT)-Üst Ekstremite ve YDT-Alt Ekstremite testleri kullanılarak değerlendirildi. Tüm denekler için toplam FHA, YDT-Üst Ekstremite ve YDT-Alt Ekstremite puanları hesaplandı.

Sonuçlar: Saha içi pozisyonlar, kaleci (n=7), oyun kurucular (n=24), kanat oyuncuları (n=13) ve pivot (n=10) olarak dağılmaktaydı. Sahadaki pozisyonlara göre, pivotlar ve kaleciler FHA ve YDT-UE değerlendirmelerinde en düşük puanlara sahip olarak belirlendi ($p<0,05$).

Tartışma: Bu çalışmanın sonuçlarına göre, kaleci ve pivot pozisyonlarında oynayan oyuncuların düşük FHA ve YDT-Üst Extremite skorları nedeni ile daha yüksek yaralanma riskine sahip olabileceği belirlenmiştir. Bu sonuçlar, antrenörlerin ve oyuncuların mevcut durumu gözlemlemelerine ve yaralanma önleme programlarını uygulamalarına olanak sağlayacaktır.

Anahtar Kelimeler: Sporcu; Yaralanma; Risk Değerlendirmesi; Spor.

INTRODUCTION

Handball is the 4th popular sport in Europe following soccer, volleyball, and basketball, and is competed in the Olympics since 1972 (1). In other team sports such as soccer and basketball, injuries are common for both genders and all ages in handball. Moreover, handball is in the first place among team sports for injury incidence. The injury incidence is reported as 63.4/1000 athletes, while 41% of the injuries occur in younger ages (2). The total incidence of injuries is reported by 104.5 per 1000 player-hours in the 24th Men's Handball World Championship (3). Detecting the injury risks is not only crucial for the success of the athletes and the teams, but also for preventing the financial loss. Therefore, it is essential to determine the risk of injury and decrease the risks, especially in younger ages (1,2).

Several methods are suggested for screening the movement characteristics and injury risk prediction. Among them, Functional Movement Screen (FMS) and Y Balance Test (YBT) are reported valid and mostly-considered assessments for detecting functionally limited areas of the athletes' body and determining the injury risk (4-7).

Lower FMS scores are found to be related to higher injury rates in sports such as soccer, ice hockey, Australian football, rugby, and running (8-10). Moreover, the normative values of the FMS scores are established in lesser populated sports as Hurling and Gaelic football (11). The injury risk in adult male handball players and FMS is considered as a tool that identifies injuries, especially for shoulder region. However, for handball players, it is suggested to use other injury risk assessment tools in addition to FMS to assess the injury risk profile. The use FMS in younger handball players is essential to determine and prevent future injuries (12).

The YBT is adapted from the star excursion balance test. It only assesses three directions as anterior, posterolateral, and posteromedial. YBT requires strength, flexibility, neuromuscular control, stability, range of motion, balance, and proprioception to be performed (7). Both lower and upper extremities could be tested using the YBT. Lower composite scores of YBT are related to higher injury risks (7). However, none of these risk-screening tools are adequately applied to handball players. To our knowledge, only a recent study from Poland has used FMS to predict injury risk in adult male handball players (12). Therefore, the present study aimed to compare the risk screening of movement characteristics, which includes scores of FMS, YBT-Upper Extremity, and YBT-Lower Extremity in 15-16 years old handball players, and to compare the scores related to the playing positions. The hypothesis of the present study was the scores of FMS, YBT-Upper Extremity, and YBT-Lower Extremity in 15-16 years old handball players would differ based on playing positions.

METHODS

Design

The cross-sectional study design was used for the study. The study was conducted between November 2016 and May 2017. The required permissions were obtained before the study. The design and methodology of the study were approved by Dokuz Eylül University Ethical Committee (Onay Tarihi: 18.11.2016 ve Onay Numarası: 2987-GOA, 2016/29-35).

Participants

Sixty elite male handball players who were invited to the U17 National Handball Team mid-season training camp were included in the study. Six players were excluded due to recent/acute injuries or moderate/severe musculoskeletal injuries in the last three months. The field positions were distributed as seven goalkeepers, 24 back players, 13 wing players, and 10 pivots. All players, who were best players in the same age group for each field position in Turkey, were elite level and qualified as players for the National Handball Team, while they continue their training and league games in their elite teams. The written and verbal informed consent were obtained from the participants and their families before the study.

Procedures

The demographic information related to age and field positions were obtained. The athletes' perceived fatigue levels were assessed using a numeric scale between 0 and 10 before the testing period. Height, weight, FMS, YBT-Upper Extremity, YBT-Lower Extremity, and body mass index were assessed. The height measurements of the players were performed in an upright position on barefoot with a standard tape, having 1-millimeter intervals. An electronic scale (Sinbo SBS-4414, Shanghai, China) measured weight of the players with a sensitivity of 0.1 kg. Body mass index calculations were performed.

All assessments were performed following a 12-hour rest, an 8-hour sleep, and the players ceased eating 2-hour before the assessment. The assessments were performed in a quiet, well-ventilated room, which had a permanent 25°C temperature and 40-50% humidity in the same period of the half-off-day. Standart explanations were given to players. The assessor was blind to the player's field position. Before the tests, warming up was obtained by performing a 5-min cycle-ergometer exercise (Voit AT-1000, Fujian, China). Tests were performed in three stations as in the order of FMS, YBT-Lower Extremity, and YBT-Upper Extremity.

Functional Movement Screen (FMS): The FMS includes seven movements and is developed to assess trunk and core strength and stability, neuromuscular coordination, asymmetry in the movement, and static and dynamic flexibility (5,6). According to FMS, injuries can be predicted by determining faults during these specific movements. Each movement is scored between 0 and 3 (3=the movement is completed as explained, 2=the movement is performed with a compensation, faulty or malalignment, 1=movement is not completed, and 0=pain during the movement or positivity in clearing tests) and a composite score below 14 indicates a risk for injury. The FMS showed a good-excellent inter- and intra-rater reliability in many studies (13,14). Only standardized explanations have been described to the players, and scoring was performed according to the standardized movement loss. The seven tests of the FMS were performed in the following order: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability. In addition, three clearing tests were performed. Each movement was repeated three times. No more attempts were required. Asymmetries during bilateral tests were recorded. In the case of asymmetry, lower scores were used as the final score (5,6).

Y Balance Test (YBT): Extremity lengths were measured before the test. While the upper extremity length was measured from acromion to the tip of the third finger, lower extremity length was measured from anterior superior iliac spine to the medial malleolus in a supine position. The YBT was performed on a movable platform based on three attached pipes (4,15). Pipes were attached in the intermediate, inferolateral, and superolateral directions. The angle was 135° between medial and lateral pipes and 90° between lateral pipes. The test was considered as failed in cases of (a) player's standing extremity's position was distorted, (b) player's reaching extremity touched to the ground, (c) if moveable platform was used as a support, (d) the player could not return to his starting position or (d) the player lifted one of the feet. The composite scores were calculated for both upper and lower dominant extremities according to the following formula (4,15):

(Anterior+Posteromedial+Posterolateral)/(3xLimb Length)x100

The abducted thumb of the player was placed in the starting line for the upper extremity. In a push-up position, warm-ups and adaptations were performed six times in each direction, starting from medial. Then, three attempts were recorded. The most extended reach was used for the analysis. The tip of the foot was placed in the starting line with barefoot shoes as the starting position of the lower extremity YBT. Warm-ups and adaptations were performed six times in each direction, starting from the anterior. Three attempts were recorded, and the most extended reach was used for the analysis.

Statistical Analysis

A post hoc power analysis was conducted using the software package, G-Power (Versiyon 3.1.9.2, Franz Paul, Universitat Kiel, Germany). The sample size of 54, four groups, was used for the statistical power analyses. The calculated effect size from means was f=0.59. The alpha level used for this analysis was $p<0.05$. The post-hoc analyses revealed that the statistical power for this study was 0.95 for detecting effect size. Statistical analyses were

Table 1: Characteristics of the Handball Players.

Variables	Handball Players (n=54)		
	Mean±SD	95% Confidence Interval	
		Upper Bound	Lower Bound
Age (years)	15.69±0.47	15.56	15.81
Height (cm)	182.80±6.53	181.01	184.58
Weight (kg)	82.09±14.28	78.19	85.99
Body-Mass Index (kg/m²)	24.52±3.77	23.49	25.55
Upper Extremity Length (cm)	78.98±3.54	78.01	79.95
Lower Extremity Length (cm)	95.98±4.00	94.89	97.07
Sports Age (years)	6.91±1.31	6.55	7.26

performed using the SPSS software version 20 (IBM Corp, 2011, Chicago, USA). Descriptive statistics were used to summarize the data. The variables were investigated using an analytic method (Kolmogorov Smirnov test) to determine the distribution of the data. Since the data were not normally distributed, Kruskal Wallis test was used to compare scores of all groups. The Mann-Whitney U test was performed to test the significance of pairwise differences using Bonferonni correction to adjust for multiple comparisons. Spearman Correlation Analysis was used for the determination of the relationships. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 54 players aged from 15 to 16 years (age=15.69±0.47 years) were included in the study. The demographic information related to age, height, weight, body mass index, upper extremity length, lower extremity length, and sports age of the handball players are given in Table 1. Demographics of the handball players according to playing position is presented in Table 2. There was no significant difference in age (p=0.994) and sport-age (p=0.995) among the groups. Wing players had significantly higher weight than goalkeepers (p<0.001) and pivots (p<0.001) based on the Mann-Whitney U test after Bonferroni correction, p<0.0083. Although there was a significant difference for height based on Kruskal-Wallis test, there was no difference between the positions (p<0.0083). Goal Keepers had significantly higher BMI than wing players (p=0.005) based on the

Table 2: Characteristics of the Handball Players Based on Playing Position.

Variables	Goal Keeper (n=7)	Back Players (n=24)	Wing Players (n=13)	Pivot (n=10)	p
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Age (years)	15.71±0.49	15.67±0.48	15.69±0.48	15.70±0.48	0.994
Height (cm)	186.14±5.52	184.33±6.92	178.46±6.52	182.40±3.03	**0.033***
Weight (kg)	93.00±12.57	80.38±13.04	70.31±4.64[¤]	93.90±13.29	**<0.001***
Body Mass Index (kg/m²)	26.88±3.38[ϕ]	23.60±3.18	22.10±1.33	28.22±4.20[φ]	**0.001***
Upper Extremity Length (cm)	79.29±3.20	80.17±3.94	76.62±2.43	79.00±2.75	**0.040***
Lower Extremity Length (cm)	97.43±2.30	97.46±4.29	93.31±3.28	94.90±3.21	**0.019***
Sports Age (years)	7.00±1.41	7.00±1.10	6.92±1.19	6.60±1.90	0.995

[ϕ]Goalkeepers had significantly higher values than wing players (p=0.005) based on the Mann-Whitney U test after Bonferroni correction, p<0.0083.
[φ]Pivots had significantly higher values than back players (p=0.005) and wing players (p=0.003) based on the Mann-Whitney U test after Bonferroni correction, p<0.0083.
[¤]Wing players had significantly lower values than goalkeepers (p<0.001) and pivots (p<0.001) based on the Mann-Whitney U test after Bonferroni correction, p<0.0083.

Table 3: Functional Movement Screen and Y-Balance Test Results of Handball Players.

Variables	Handball Players (n=54)		
	Mean±SD	95% Confidence Interval	
		Lower Bound	Upper Bound
Functional Movement Screen Total Score (0-3 points)	15.69±2.05	15.13	16.24
Deep Squat	2.46±0.69	2.27	2.65
Hurdle Step	2.06±0.60	1.89	2.22
In-Line Lunge	2.30±0.54	2.15	2.44
Shoulder Mobility	2.31±0.82	2.09	2.54
Active Straight Leg Raise	2.00±0.67	1.82	2.18
Trunk Stability Push-Up	2.57±0.66	2.39	2.75
Rotary Stability	1.98±0.14	1.94	2.02
Y Balance Test			
Upper Extremity (%)	93.15±6.52	91.37	94.93
Lower Extremity (%)	92.76±5.47	91.27	94.25

Mann-Whitney U test after Bonferroni correction, p<0.0083. Pivots had significantly higher BMI than the back players (p=0.005) and the wing players (p=0.003). Although there were significant differences in upper (p=0.040) and lower extremity lengths (p=0.019) based on Kruskal-Wallis test, there was no difference among the positions Bonferonni correction, (p>0.0083).

The FMS and the YBT results of all players are presented in Table 3. The FMS and the YBT results, based on playing positions, are gi ven in Table 4. The FMS scores were lower in the positions of pivot than back (p=0.001) and wing players (p=0.001). Wing players had higher YBT-Upper Extremity than pivots and goalkeepers (p=0.001), while there were no differences for YBT-Lower Extremity among the positions (p=0.003).

All handball players, YBT-Upper Extremity score, was significantly related to the YBT-Lower extremity score (Spearman's rho=0.404, p=0.002), and FMS total score (Spearman's rho=0.304, p=0.025). YBT-Lower Extremity score was not significantly associated with FMS total score (Spearman's rho=0.228, p=0.097).

DISCUSSION

We found a differences among the playing positions according to FMS, YBT-Upper Extremity, and YBT-Lower Extremity values. Due to the reported high rate of injury incidence for handball, especially in the younger ages, the present study aimed to compare the values of the injury prediction tests as FMS,

Table 4: The Y-Balance Test and the Functional Movement Screen Results According to Playing Positions.

Variables	Goal Keeper (n=7)	Back Players (n=24)	Wing Players (n=13)	Pivot (n=10)	p
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Fatigue Pre-Testing (0-10)	1.57±1.13	2.04±0.75	1.77±1.01	2.20±0.63	0.583
FMS Total Score (0-3)	15.00±0.82	16.33±1.69	16.69±1.55	13.30±2.11$^{\phi}$	**<0.001***
Y Balance Test					
Upper Extremity (%)	88.79±7.22	93.06±6.10	98.38±4.26$^{\varphi}$	89.60±5.30	**0.003***
Lower Extremity (%)	89.93±3.77	91.56±4.34	97.30±6.63	91.70±4.36	**0.019***

*p<0.05. Kruskal-Wallis test. FMS: Functional Movement Screen.
$^{\phi}$Pivots had significantly lower values than back players (p=0.001) and wing players (p=0.001) based on the Mann-Whitney U test after Bonferroni correction, p<0.0083.
$^{\varphi}$Wing players had significantly higher values than goalkeepers (p=0.003), and pivots (p=0.001) based on the Mann-Whitney U test after Bonferroni correction, p<0.0083.

YBT-Upper Extremity, and YBT-Lower Extremity according to playing positions in professional handball players, who were aged 15-16 years. These differences showed that different injury prevention training programs should be applied according to the playing positions in handball. As to our knowledge, the present study is the first, providing such results in young handball players.

According to FMS scores in our study, pivot players might have higher injury risk compared to back and wing players. These results also showed that FMS screening should be performed before the competition season. The FMS has used for predicting sport-related injuries in many sports (8-11,16-20). The FMS has been used to predict injury risk in adult male handball players, in a recently published study from Poland. The authors focused on the asymmetries between extremities during FMS-subtests and determined a significant difference in the shoulder mobility test. They also collected the injury history related to the last 12-months and 6-months following FMS testing, and concluded that presence a previous injury was the only significant indicator of a future injury. The authors reported that back players (46%) were the most injured ones, and goalkeepers (23%) were the second. Goalkeepers did not show lower scores than other positions. However, Slodownik et al. did not provide the FMS results or injury history related to playing positions. Therefore, the high rate of injury in back players might result from previous injuries (12). The authors also suggested using other injury prediction tools to assess the injury risk in handball players. We applied YBT tests in addition to FMS for the injury risk detection, and according to our results, goalkeepers and pivots showed lower YBT-Upper Extremity scores. Moreover, FMS composite scores were found positively related to YBT-Upper Extremity scores in the present study. These findings indicated that the players in these positions might need player-specific training and injury prevention programs.

Abraham et al. (21) reported that the mean FMS score was 14.93 for healthy school children aged 10-17 years. However, we determined the FMS score as 15.69 for 15-16 years old handball players, and pivots had an FMS score of 13.30. This difference could be explained by regular exercise in our group, and being closer to the upper limits of the age range of the study of Abraham et al. (21). Perry et al. (22) investigated FMS scores among adults and found a score of 14.79 in young adults. Fox et al. (11) found FMS scores as 15.56 in Gaelic footballers with a mean age of 22.15 years. These findings could be interpreted as age is not a predictor in FMS score, but regular exercise would affect the score.

A score of 14 and below was advocated as multiplying the injury risk 4-11 times in previous studies (23,24). While the mean FMS composite score was 15.69 in our study, the mean FMS score of the pivots was determined as 13.30, which might be interpreted as an increased injury risk for this field position.

Rowan et al. (25) mentioned that FMS was used as an assessment criterion for the qualification of the athletes in team sports. In the present study, subjects were already qualified for the National team without an FMS screening. However, according to our results, some players, even if they were in National team, might have higher injury risk levels. Therefore, if FMS is not used for qualification, it should be used to identify and correct movement patterns for athletes at risk of injury before or during the competition season.

The balance was reported related to injuries in sports. McGuine et al. (26) showed that balance scores might be used as a predictor for ankle injuries. Therefore, the YBT used as the balance assessment in the present study. Although, there is no previous information about the relationship of injury rates and YBT test scores in handball, Gonell et al. (7) indicated that YBT-Lower Extremity composite scores were related to total injury rates and non-contact injuries in soccer players. The authors also stated that injury rates would be double for the players who have a score of lower than 99.91. In contrast to soccer, which mostly the lower extremities used, handball requires the use of both upper and lower extremities. Therefore, in the present study, both lower and upper extremities were examined.

Normative composite scores of YBT-Upper Extremity and YBE-Lower Extremity were found 93.15 and 92.76, respectively. Only male players included in the present study. Our results might provide a basis for further study related to balance and injury rates.

Pivots and goalkeepers also had higher BMI values. Considering that increased BMI also increases the risk of injury, it may be associated with low FMS and YBT scores of pivots and goalkeepers in general. The perceived fatigue level assessed during the measurements was not different among the positions. In addition, no difference at the players' sports age according to the positions showed that the athletes were practising handball for a long time, and they had close experiences.

The range of age in the present study could be counted both as a strength and a limitation. The limited range of age could restrict the generality of the results but provide more accurate information for a specific age range. Although the gender indifference related to YBT and FMS scores was shown in previous studies, the same parameters should also be examined in female handball players. In addition, the nature of a cross-sectional study could limit the applicability of our findings. Therefore further prospective study is needed to confirm our results.

In conclusion, players who compete in the positions of goalkeeper and pivot might have higher injury risk due to lower FMS and lower YBT-Upper Extremity scores. This data would allow trainers and players to observe the current status and to implement the injury prevention programs. In addition, health providers, physiotherapists or team doctors, arrange rehabilitation programs and determine the time to return to play goals using these findings. According to our results, goalkeepers and pivots need special attention for injury prevention.

Sources of Support: None.

Conflict of Interest: None.

Ethical Approval: The study design and methodology were approved by Dokuz Eylül University Ethical Committee (Approval Date: 18.11.2016 and Approval Number: 2987-GOA, 2016/29-35).

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