Differences in Upper Quarter Y Balance Test Performance According to Playing Position in Youth Handball Players

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Research note

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Abstract

Objective

Handball is an Olympic intermittent sport with different playing positions that can be differentiated between first line players who positions themselves near the 6-m line and second line players who typically play outside the 9-m space. Additionally, goalkeepers have a distinctive role as they mostly only play within their own 6-m space. The objective of the study was to assess whether the specific physiological positional demands in handball lead to functional performance differences between the playing positions in terms of shoulder mobility and stability in any reach direction as assessed through the Upper Quarter Y Balance Test (YBT-UQ).

Results

No significant differences in any reach direction of the YBT-UQ were found between the playing positions, irrespective of reach arm and reach direction. The obtained effect sizes (η_p^2) were solely small and ranged between .003 and .030.

Introduction

Handball is a face-paced intermittent high-intensity Olympic contact sport [1]. It is characterised by a high number of throwing actions [2] which cause adaptations in the throwing shoulder [3, 4]. In accordance with the playing positions of the players, different throwing demands, techniques and biomechanical consequences are present. Handball playing positions in offense can be divided into first line players who are positioned near the 6-m line; and the second line players who typically position themselves outside the 9-m space. Pivots and wingers are therefore considered as first line players, whereas backcourt players, i.e. back left and back right as well as the centre are second line players. The first line players seldom have to throw over a defender due to their near position to the goal, whereas the second line players often have to throw over defenders from wider distances [5]. These differing throwing necessities typically lead to the first line players executing throws with less throwing velocity but higher demands in terms of accuracy [6]. Side arm throws with a long arm are especially present in throws of the wingers together with curved jumps [7] to improve the angles from the outer positions. Contrary to this, backcourt players mostly use overhead throws with a long arm being extended more into a horizontal direction to be able to throw over defenders who try to block. Backcourt players typically position themselves within the central zone in which body contact and 1 against 1 situations are more frequently displayed than on the wings [8–10]. Based on these differences, it might be possible that the functional adaptation in terms of shoulder mobility and shoulder stability differs between playing positions, especially between the first and second line players. Goalkeepers do represent a distinctive playing position [9] as they normally only play in defence. Goalkeepers need to be rather tall [11] while remaining flexible enough to save throws from different angles with their whole body. It could therefore be assumed, that goalkeepers display

higher mobility and stability in the shoulder girdle due to their increased demands in terms of flexibility when saving throws. However, the functional adaptation and influence of throws executed by goalkeepers themselves is less likely, as they mostly perform short passes and considerably less throws with much lower velocities.

However, up to date there is no study comparing the functional adaptations, especially of the upper extremities, between the different playing positions in youth handball players. The Upper Quarter Y Balance Test (YBT-UQ) is a closed kinetic chain test [12] with the potential to assess shoulder mobility and stability in interaction with the trunk [13]. Therefore, the aim of the study was to identify differences in shoulder mobility and stability between playing positions. We assumed differences between the playing positions due to their diverging demands.

Methods

Participants

The study population represented a homogeneous group in terms of playing level (Table 1). All players are members of regional youth selection teams with a training frequency in their respective clubs of 3–4 training sessions per week.

Table 1
Characteristics of the study participants (*N* = 196) by player position

Characteristic	Goalkeeper (<i>n</i> = 25)	Backcourt (<i>n</i> = 99)	Pivots (<i>n</i> = 21)	Wingers (<i>n</i> = 51)
Sex [f/m]	9/16	46/53	9/12	22/29
Age [yrs]	14.8 ± 1.7	15.2 ± 1.6	15.7 ± 1.4	15.4 ± 1.5
Body height [cm]	174.9 ± 10.2	176.8 ± 9.3	179.1 ± 9.5	171.8 ± 7.9
Body mass [kg]	72.4 ± 15.3	71.0 ± 12.4	77.3 ± 13.0	62.5 ± 9.8
BMI [kg/m²]	22.5 ± 5.8	22.6 ± 3.0	24.1 ± 2.9	21.2 ± 3.2
Left arm length [cm]	88.9 ± 6.6	89.1 ± 5.5	90.6 ± 4.9	86.5 ± 4.7
Right arm length [cm]	89.3 ± 7.3	89.6 ± 5.1	91.2 ± 4.8	86.8 ± 5.0
Arm dominance [l/r]	1/24	7/92	2/19	7/44
Throwing arm [l/r]	0/25	6/93	0/21	9/42
Training experience [yrs]	8.1 ± 3.3	8.0 ± 2.9	8.3 ± 2.7	8.6 ± 3.0
Data are mean ± standard deviation. BMI = body mass index; f = female; m = male; l = left; r = right.				

Testing procedures

The testings were carried out on four different measurement dates with four different testing groups. A standardized warm-up including five minutes of submaximal running and a mobility routine was executed by every participant prior to the testings. Anthropometric and YBT-UQ assessments were executed in a random order with identical graduated testing personnel being present at all testings. Following the stations, the groups were given a 5-min break before starting the next station to minimize fatigue. Standardized verbal instruction was given prior to the execution of the YBT-UQ.

Assessment of anthropometric characteristics

From the seventh cervical spinous process to the distal tip of the middle finger upper limb, length was measured with the shoulder being in a 90° extension [14]. A Seca clara 803 digital scale was used to assess body mass (kg). Standing body height (cm) without shoes was assessed with a Seca linear measure scale. Players stated their training experience in years and their dominant playing position together with their dominant and throwing arm.

Assessment of Upper Quarter Y Balance Test performance

The Y Balance Test Kit (Move2Perform, Evansville, USA) was used to assess the three reach directions medial (MD), inferolateral (IL), and superolateral (SL). A standardized verbal instruction was given by one of the testers prior to the execution. The left arm had to be placed at the centre of the junction to reach out to the furthest point of each reach direction with the right arm. This protocol was then replicated for the other body side. Trials were invalid if three-point contact was lost or the participant touched the floor with the mobile arm or hand [13]. The best score (i.e. maximal reach distance) was noted for every reach direction being normalized for arm length (AL) and an additional normalized composite score (CS) as the mean of the averaged maximal distances in all reach directions.

Statistical analysis

Mean values and standard deviations were calculated and YBT-UQ performance differences between groups of player position were investigated by using an analysis of variance (ANOVA) with additional post hoc comparisons. Furthermore, effect size (η_p^2) was calculated and classified as small ($0.02 \leq \eta_p^2 \leq 0.12$), medium ($0.13 \leq \eta_p^2 \leq 0.25$), and large ($\eta_p^2 \geq 0.26$). The level of statistical significance was set at $p < 0.05$. All statistical analyses were made with the statistical package for social sciences, version 27.0 (SPSS Inc., Chicago, Illinois, USA).

Results

The mean values and standard deviations for the normalized YBT-UQ performance by reach arm and player position is shown in Table 2. Irrespective of reach arm and reach direction, the ANOVA revealed no significant performance differences between player positions. In addition, the obtained effect sizes were

Table 2
Comparison of YBT-UQ performance by player position

Outcome	Goalkeeper (<i>n</i> = 25)	Back (<i>n</i> = 99)	Pivot (<i>n</i> = 21)	Winger (<i>n</i> = 51)	<i>p</i> -/ η_p^2 -value
<i>Right arm reach</i>					
MD (% AL)	98.5 ± 18.2	106.2 ± 14.6	107.2 ± 18.8	106.9 ± 13.8	.115 (.030)
IL (% AL)	102.4 ± 16.8	103.8 ± 15.9	105.5 ± 17.3	104.7 ± 13.8	.901 (.003)
SL (% AL)	83.0 ± 11.5	84.3 ± 11.5	84.3 ± 13.8	85.2 ± 11.2	.887 (.003)
CS (% AL)	94.6 ± 9.0	98.1 ± 8.7	99.0 ± 8.3	99.0 ± 8.7	.198 (.024)
<i>Left arm reach</i>					
MD (% AL)	97.7 ± 19.0	104.7 ± 13.6	105.3 ± 16.5	105.6 ± 12.9	.128 (.029)
IL (% AL)	104.8 ± 16.0	102.1 ± 16.6	103.4 ± 16.5	103.8 ± 14.4	.866 (.004)
SL (% AL)	80.2 ± 13.7	82.6 ± 11.4	82.3 ± 9.7	84.3 ± 12.7	.547 (.011)
CS (% AL)	94.2 ± 9.7	96.4 ± 9.2	97.0 ± 8.2	97.9 ± 9.2	.424 (.014)
Data are mean ± standard deviation. Partial eta squared (η_p^2) can be classified as being small ($0.02 \leq \eta_p^2 \leq 0.12$), medium ($0.13 \leq \eta_p^2 \leq 0.25$), or large ($\eta_p^2 \geq 0.26$). AL = arm length; CS = composite score; IL = inferolateral; MD = medial; SL = superolateral.					

Discussion

Contrary to our expectation, the results did not show significant differences between the playing positions in shoulder mobility and shoulder stability as assessed through the YBT-UQ in youth handball players. Contrary to senior players for whom anthropometric differences are well documented between the different playing positions [5], the present sample also only showed small anthropometric differences between the playing positions with the exception of pivots being taller and heavier than the wingers (see Table 1).

The results are contrary to Patel and Choudhary [15] who were able to detect significant differences between the playing positions of handball players applying the long nose test. In terms of static balance abilities and postural priority, Jadczyk et al. [16] reported significant differences between playing positions, with midfielders achieving better results than the other playing positions. These findings go in line with Brumitt et al. [17] who detected significantly greater posterolateral and composite reach measures bilaterally in the Lower Quarter Y Balance Test (YBT-LQ) in liberos/defensive specialists/setters. In baseball, a sport comparable to handball in terms of upper extremity importance, Ryu et al. [18] were able to detect significant differences between the pitchers and infielders in mean right

What are likely explanations for our finding that YBT-UQ did not differ according to player position? First, the anthropometric differences between the playing positions are rather low except for pivots compared to wingers, which is contrary to the anthropometric characteristics reported in senior handball being rather huge [19]. Second, the overall training load of youth handball players is not sufficient to lead to a diversification in the functional adaptation according to playing positions. This may be underlined by the 8–9 years of training experience of the present sample and the fact that youth players especially at the very beginning of their handball career mostly have low training frequencies of 1–2 training sessions while having 3–4 training sessions at the times of the testing and a game per week, possibly being not sufficient to lead to the according functional adaptations. These may not solely be a result of the current training load but also the rather small past training load. Therefore, the dose response relationship [20] of handball-specific training and the subsequent overall training load may not be sufficient to lead to diverging neuromuscular adaptations or changes in the tendon or bony structures of youth handball players. Third, the positional specialization may be lower in youth than in senior players with the former one being used more often in different positions. More specifically, a high number of techniques like blocking, screening, or initiating body contact as a defender are executed with both arms in equal distribution possibly neutralizing the effects of the unilateral technique executions while passing and throwing.

Conclusion

The on-court physical demands of the different playing positions in youth handball players do not lead to significant differences in shoulder mobility and stability as assessed through the YBT-UQ. Longitudinal studies are needed to assess if differences occur during the period from junior to senior handball. Further, tests for throwing velocity or upper-extremity muscle strength may be additionally helpful to assess if positional differences exist in other functional parameters.

Limitations

There are a few limitations that need to be addressed. The study population represents an unequal distribution in terms of playing positions and the ratio of male and female players. Further, only the dominant playing position of the athletes was assessed with the consequence of some subjects playing this position for most of the time during training and games but sometimes also playing other positions.

Abbreviations

AL: arm length; BMI: Body mass index; f: female; IL: inferolateral; m: male; MD: medial; SL: superolateral; YBT-UQ: Upper Quarter Y Balance Test; YBT-LQ: Lower Quarter Y Balance Test

Declarations

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Authors` contributions

TM and JB designed the research question. JB and GS planned and supervised the testings. TM analyzed the data. JB wrote the main part of the manuscript. TM and GS reviewed the manuscript. All authors approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from Julian Bauer, University of Duisburg-Essen, on reasonable request.

Ethics approval and consent to participate

Ethical permission was given by the Human Ethics Committee at the University of Duisburg-Essen, Faculty of Educational Sciences. Participants *assent* and *parents* written informed consent were obtained prior to the start of the study.

Consent for publication

Not applicable.

Competing interests

All of authors declared that they have no competing interests.

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