



Correlation between Clark angle and Performances in Icelandic Female Basketball Players

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Abstract

Basketball is a highly anaerobic game, that consists of high-intensity efforts followed by lower-intensity efforts. Postural deformities can be a limiting factor in achieving maximal performances in basketball. Flat feet are one of the most common deformities and they can lead to discomfort and pain. In this research we made an attempt to link the degree of feet flatness with sports performances in elite Icelandic female basketball players. A sample of 15 basketball players was tested on a podoscope to establish the degree of feet flatness and all participants performed drop jump, countermovement jump, 20m sprint and agility t-test. No significant correlation was observed, which means that feet flatness was not a limiting factor. However, we state that only strong and healthy feet might lead to excellent performance.

Keywords: basketball, Clark angle, performances, females

Introduction

Basketball is a complex, high-intensity anaerobic sport that consists of high-intensity efforts followed by lower-intensity efforts. With its increasing worldwide popularity, participation and monetary value, basketball provides a great opportunity for strength & conditioning coaches (Jeffreys & Moody, 2016) to enhance the performance of players, who are required to achieve and endure a high level of mechanical power to perform jumping, sprinting, change of direction, acceleration, deceleration, and anaerobic capacity. Previous reports have shown that during competitive basketball games, players execute up to 50 jumps (Montgomery et al., 2010), an average of 105 high-intensity bouts (2 to 6 sec), occurring every 21 sec (McInnes et al., 1995), with the sprint intensity varying between 15 m·min⁻¹ (Scanlan et al., 2011) and 19 m·min⁻¹ (Abdelkrim et al., 2010) which makes it one of the most demanding games.

Postural deformities in basketball did not attract bigger attention of researchers, with only a few of them making an attempt to analyse their frequency and relationship with success in jumping abilities.

Puzovic et al., (2016) have shown that the prevalence of flat feet deformity among 64 subjects (age 10-12) in their study

was 64.06% and they have observed a statistically significant difference between the sexes, and among children of different age. A limitation of this study was that the feet status was determined only visually, so these findings should be considered carefully. Ho et al., (2019) have shown no differences in vertical and horizontal jump performances between flat-footed and normal arched. Their sample consisted of twenty-six male basketball players which were recruited from the teams in three local universities in Beijing, China. Sajedi et al., (2018) did not find any statistically significant differences in jumping abilities between groups of primary school boys and girls with and without flat feet. Meanwhile, Petrović et al., (2013) suggest that flat feet are not a disadvantage in performing sport activities but can certainly cause other postural deformities.

Positive correlation between body mass index (BMI) and flat feet disorder has been found in the work of Aurichio et al., (2011) and Pourghasem et al., (2016). According to Suciati et al., (2019), people who are overweight/obese have a 2.36 times risk for flat feet compared to people who are not overweight.

To the best of our knowledge, no previous studies investigated the relationship between the degree of foot flatness and sports performances in adult female basketball players,

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therefore, the aim of this study was to investigate further this phenomenon.

We hypothesised that flat feet may be related to athletic performance.

Methods

Study design

Conceptually, this is a cross-sectional, descriptive study.

Participants

The sample size consisted of 15 basketball female players (age 20.9 ± 6.57 ; BMI 21.7 ± 2.34), playing for basketball club Fjölnir from Reykjavik, in Icelandic Womens' Premier League, known as Subway deild kvenna. Data collection was conducted in preseason. This study was approved in advance by the University of Iceland. Each participant voluntarily provided written informed consent before participating (and in case of minors their parents), and all experiments were conducted in line with Helsinki declaration. All players satisfied inclusion criteria for this study: participating voluntarily, playing basketball for more than 5 years, being injury free for the last 6 months, attending regular basketball training sessions, and did not have any type of cognitive or physical limitations. Participants were informed that their participation is voluntary and that they could withdraw from the study at any time without providing any explanation.

Anthropometrical status

Body weight and body height were measured individually in a closed room in the sports hall, as well as the feet status. All measurements were conducted following the International Biological Program – IBP guideline. A podoscope Multireha was used to evaluate feet status. After stepping barefooted on a platform of the podoscope, a snapshot was taken and used later for the analysis with the embedded software. This software automatically calculated the Clark angle. As illustrated in Figure 1., the Clark angle consists of plotting a straight tangent to the inside of the foot and a straight tangent to the curvature of the arch. Angle description: $< 30^\circ$ - flat foot, 31° - 41° - foot

with lowered arch, 42° - 54° - normal foot; $55^\circ >$ hollow foot.

Performance measurements

Data collection was conducted in a basketball hall, after all participants completed a warm up that consisted of 10 minutes jogging followed by dynamic stretching. All participants performed the tests 3 times and the best result was taken into further analysis.

Jumping assessment

Drop jumps (DJ) and countermovement jumps (CMJ) were tested with an optical measurement system consisting of a transmitting and receiving bar (Optojump, Microgate, Bolzano, Italy). Players were given verbal encouragement during the test.

Running and agility assessment

Timing gate system Witty has been used to measure time. All players had three attempts to run 20-meter distance with 2 minutes break in between the trials. The agility T-test was used to determine speed with directional changes such as forward sprinting, left and right shuffling, and backpedalling (Haj Sassi et al., 2009).

Statistical analysis

All statistical analysis were performed in Jamovi program and figures were made in Microsoft Excel. Mean and standard deviation were calculated for all variables (Table 1). The correlation between Clark angle and all other variables was examined with the Pearson correlation coefficient (where $r = \pm 0.10$ is a weak correlation, $r = \pm 0.30$ is a medium correlation and $r = \pm 0.50$ is a strong correlation) and presented in Table 1. An R-squared values were presented to measure how well a statistical model predicts an outcome.

Results

No significant correlation between Clark angle and any of anthropometric or performance tests were observed (Table 1).

Table 1. Descriptive Statistics and Correlation Matrix

variable	Age (year)	BW (kg)	BH (cm)	BMI (kg/m ²)	T-test (sec)	20m (sec)	CMJ (cm)	DJ (cm)	Clark angle (deg)
Mean	20.9	65.9	174	21.7 (2.34)	10.5 (0.40)	3.38 (0.17)	34.4 (6.94)	33.4	56.1
(SD)	(6.57)	(9.69)	(8.55)					(7.85)	(6.70)
Pearson's r	-0.070	-0.365	-0.232	-0.280	-0.050	0.058	-0.111	-0.043	
p-value	0.803	0.180	0.405	0.312	0.860	0.836	0.694	0.878	

Values are means (SD). BW: Body Weight; BH: Body Height; BMI: Body Mass Index; CMJ: countermovement jump; DJ: drop jump.

Discussion

In this paper we investigated the correlation of the degree of feet flatness, expressed as the Clark angle with anthropometric data and sports performances. No significant correlation was observed in any of the variables, which means that the degree of feet flatness does not play an important role in sports performances, despite popular believe. As indicated before (Petrović et al., 2013), flat feet were not disadvantageous for sports performances, but certainly they can lead to a number of different postural deformities, where increased foot pronation, if the muscle structures are not strong enough, might lead to increased knee valgus and consequently to spine deformation. Despite previous findings (Sajedi et al., 2018; Ho et al., 2019; Petrović et al., 2013) that flat feet were not disad-

vantageous for jumping and sprinting in various populations, this research has shown a detailed analysis and importance of measuring feet status in a particular way, rather than just using conventional models. Lower values of the Clark angle indicate a higher degree of feet flatness, and this is, in our knowledge, the first time that this kind of investigation was conducted.

Our cohort was similar to the one that has been described in the study by Zody et al., (2011), where participants were 14 NCAA Division-1 female basketball players (age: 19.3 years, body mass: 76.1 kg, body height: 178.7 cm). A similar group, but slightly older and with lower BH and BMI was observed in the work of Haj Sassi et al., (2009), (age: 22.6 years; weight: 63.7 kg; height: 165 cm; BMI: 23.3. Mala et al., (2015) investigated body composition of elite female players in five different

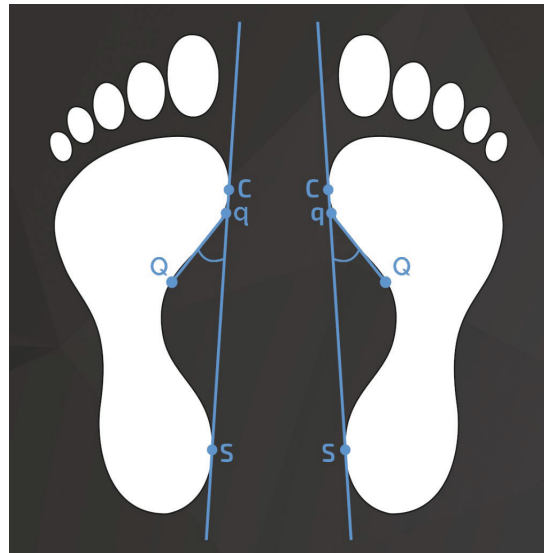


Figure 1. Clark angle

sports, where basketball players were slightly taller and heavier than the participants in our study. Values of jump height in CMJ were reported in the work of Laffaye et al., (2014), 46.8 cm; Legg et al., (2017) 39.0 cm, Delextrat & Cohen (2009), 42.5 cm while our study shows that basketball players jumped 34.4 cm, significantly less than in those studies.

Delextrat & Cohen (2009), also investigated strength, power, speed, and agility of women basketball players according to playing position and in their study on English National League Division II players, they have reported values of 10.45 seconds for agility T-test and 3.50 sec running 20m sprint, both values

very similar to our findings.

Despite the novelty of the analysis made in this work, where participants were not strictly divided in groups with and without flat feet, we would like to acknowledge one limitation. The study was conducted on a quite unique and small sample that consisted of 15 female basketball players from one team in the first division in Iceland, so further studies should include larger samples. However, these results and its findings can help strength & conditioning coaches to think how individual sessions should be planned and that the emphasis on a proper feet function must be taken into consideration every day. Regular,

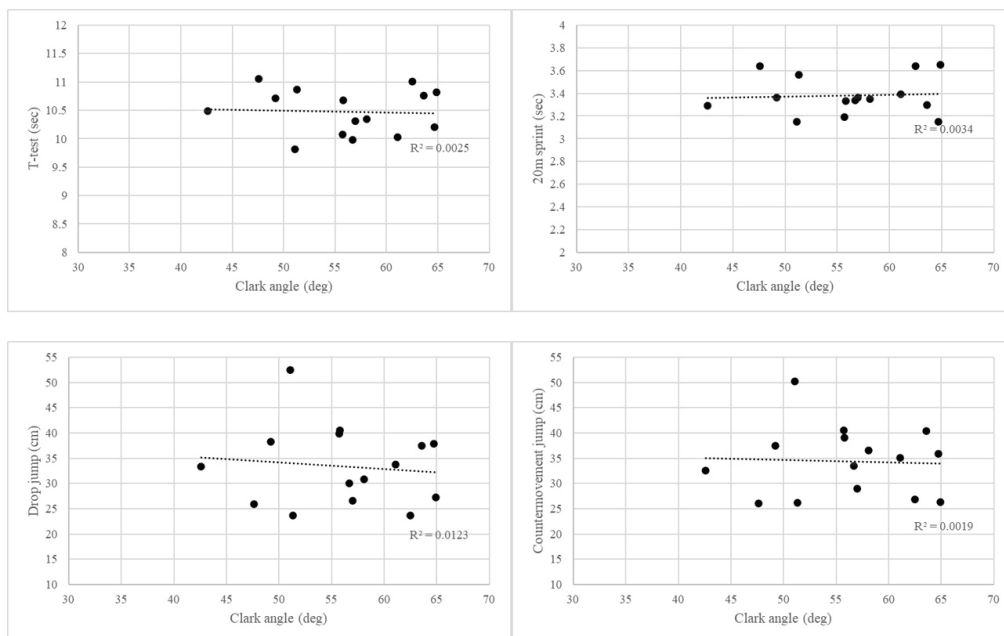


Figure 2. Correlation between Clark angle and performance measurements

persistent, and everyday work on injury prevention should include exercises for feet, since the whole body is supported by them, and the game quality relies on good posture.

The novelty of this work is that for the first time flat feet analysis went a step further and moved from conventional grades to the examination of Clark's angle of individuals and

how it is correlated with performances in basketball.

In conclusion, the degree of feet flatness has not been linked to success in sports performances in basketball, but attention should be paid to strengthening all parts of the body, particularly feet, a unique structure that holds the whole body and helps it to move in various directions and ways.

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