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ANTHROPOMETRIC AND PHYSICAL PERFORMANCE CHARACTERISTICS IN AFRICAN WOMEN FOOTBALL PLAYERS: A CROSS-SECTIONAL PILOT STUDY

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Abstract Being injured is inherent to participating in football activities; therefore, prevention of injuries is crucial. This requires that the risk factors for injury be established. However, such studies are rarely conducted in women athletes in Africa. The study's aim was to explore intrinsic risk factors for injury among African women football players using functional and musculoskeletal assessments. Participants (n = 40) completed demographic questionnaires; upper and lower limb active range of motion (AROM); muscle endurance and functional movement screening (FMS™) assessed. Median age [Q1; Q3] was 24 [20; 27] years. Participants performed 20.5 [0; 30.5] push-ups and 28 squats [30; 38] in 60s; and held the prone elbow plank for 46.2s [30.6; 64.5]. Median FMS™ score was 12 [10; 13]; most players (n = 27, 68%) could not execute a proper deep squat. Most players (70%; n = 28), were able to properly perform the in line lunge but scored poorly in the shoulder mobility domain of the FMS™, with 73% (n = 29) scoring ≤1. Players with a history of injury had lower FMS™ total (p = 0.02). Overall, participants presented with low muscle endurance and movement imbalances, which might predispose them to injury. Hence, strength and conditioning measures should be instituted in this population to prevent injuries.

Key words injury risk, muscle endurance, limb ROM, FMS, women's football, Africa

Introduction

Football is the most popular team sport worldwide (Williams, Coopoo, Fortuin, Green, 2019) and participation levels continue to increase (FIFA, 2014). However, participation in football carries an inherent risk of injuries (Junge, Dvořák, 2015). Therefore, prevention of injuries is crucial. In order to design effective preventative interventions, the aetiology and mechanisms of injuries should first be established (Van Mechelen, 1997). This includes assessment of the risk factors that are associated with these injuries. These are classified as intrinsic (inherent to the athlete e.g. age, muscle strength, flexibility) or extrinsic (external to the athlete e.g. training load, training surface) (Dvorak et al., 2000). To date, studies have identified risk factors for injuries in team sports such as rugby and football (Svensson, Alricsson, Olausson, Werner, 2018) and relevant preventative measures such as the FIFA 11+ program in football (Al Attar, Alshehri, 2019) and BokSmart in rugby (Sewry, Verhagen, Lambert, Van Mechelen, Brown, 2017) have been developed as a result.

Despite football being the most popular team sport among women and girls worldwide and participation increasing yearly (FIFA, 2014), relatively few of the studies on risk factors for injury have been conducted on women athletes in general or women football players specifically (Cruz, Oliveira, Silva, 2020). Hence, preventive measures developed are often derived from male cohorts. Furthermore, studies identifying risk factors for injuries among African women footballers are even scarcer as African women football players are currently on the periphery of global football medicine discourse (Mkumbuzi, Chibhabha, Zondi, 2021). When sustained, injuries in football players in low- and middle-income settings such as sub-Saharan Africa have different implications to those faced by their counterparts in high income settings as medical care is very limited in the former (Killowe, Mkandawire, 2005); therefore, primary, and secondary prevention of injuries is imperative in the former. However, the current paucity of empirical evidence that relates to women footballers in general and African women footballers specifically impairs the ability of team support personnel to prescribe preventative and treatment interventions that are relevant to this population. By understanding the particular risk factors that are unique to African women football players, interventions can be targeted towards their specific biopsychosocial circumstances (von Rosen, Frohm, Kottorp, Fridén, Heijne, 2017). This will improve assessment of injury risk, optimise prescription of prevention and treatment strategies as well as derive conclusive and appropriate recommendations for safe participation in football for African women football players. Therefore, the aim of this study was to investigate the intrinsic injury risk profiles of African women football players using functional and musculoskeletal screening assessments to provide an evidence base on which to develop or improve available injury prevention or interventions strategies in this population and promote safer participation in football.

Material and methods

Ethical clearance to conduct the study was obtained from the Faculty of Medicine Research Ethics Committee, Midlands State University, Zimbabwe (MSUFMEC 0002/10/20) and permission was obtained from the world football governing body and the tournament organisers. Participation in the study was voluntary, and it was conducted according to the principles of the Helsinki Declaration. In addition to permission, verbal and written informed consent to participate in the study were obtained from the participants.

This study assessed injury risk parameters in African women football players participating in the 2020 Council of Southern African Football Associations (COSAFA) Women's Championship held in Gqeberha (formerly Port Elizabeth), South Africa.

All senior (≥18 years old) football players participating in the tournament (n = 177) were eligible to participate in the study. Players who had any injuries at the time of testing were excluded. The players were requested to present for testing at a time and day that was convenient for them during the tournament. This pragmatic approach for recruitment and testing was adopted to minimise disrupting their training, competitive, and recovery schedules. At the visit, (1) demographic and anthropometric measures, (2) musculoskeletal assessments, (3) functional movement screening (FMS™), and (4) muscular endurance were assessed. This array of tests has been used previously to assess injury risk in team sports (Mtsweni, West, Taliep, 2017; Sewry et al., 2017).

Demographic data such as calendar age, skill level, training and injury history were recorded on a self-administered questionnaire and anthropometric data were measured including height (wall tape measure), mass (balance) and limb girths (tape measure). The girths of the upper limb (at deltoid insertion), abdomen (at the navel), hip (widest part of the hip), thigh (halfway between the hip and knee joints), and calf (widest part of the calf) were measured as proxies for muscle girth.

Following this, a sports physiotherapist (NSM) conducted musculoskeletal assessments: active knee extension, modified Thomas test, active internal and external rotation of the hip (seated position, hip and knee at approximately 90° flexion), ankle dorsiflexion (weight bearing lunge test), sit and reach, lumbar spine extension, lumbar spine forward flexion, and shoulder internal and external rotation, as reported in previous literature (Sewry et al., 2017). The Functional Movement Screen (FMS™) (Chalmers et al., 2017) was then administered. The FMS involves the participant performing the deep overhead squat, single leg hurdle step, in line lunge, active straight leg raise, trunk stability push up, seated rotary stability and shoulder mobility (Chalmers et al., 2017). The movement patterns are scored from 0 (pain with execution of movement) to 3 (perfectly executed movement) points, with the total score ranging from 0–21 points (Cook, Burton, Hoogenboom, 2006a, 2006b). Muscle endurance of the upper-limbs was measured using the modified push-up test. Participants started the test with their knees bent on the floor, their hands shoulder width apart on the floor, with a straight back (Mtsweni et al., 2017). The total number of modified push-ups performed in 30s and 60s was recorded. Muscle endurance of the mid-body/core was measured with the prone elbow plank to exhaustion (Abdallah, Mohamed, Hegazy, 2019). Muscle endurance of the lower body was measured using deep squats (Eckard et al., 2018). The total number of squats performed in 30s and 60s was recorded.

Statistical analyses

The data were analysed using STATA™ v 14 (StataCorp, Texas, USA). Data for each outcome variable were tested for normality using the Shapiro-Wilk's test. Continuous variables are presented as mean ± standard deviation [or median (Q1; Q3)] and categorical variables as n(%). If normally distributed, comparisons among the participants were performed using the t-test. Otherwise, then the Wilcoxon signed rank test or Kruskall-Wallis test were used. The Pearson's Chi square test was used to test for associations among categorical variables. Where significant differences were found, univariate models (logistic for categorical variables; linear for continuous variables) were performed to determine where the differences were located. Level of significance was set at $p \leq 0.05$.

Results

Of the 177 football players who participated in the 2020 COSAFA Women's tournament, 40 (22.5%) agreed to participate in the study. The median age [Q1; Q3] of the participants was 24 [20; 27] years (Table 1). Nearly

Table 1. Demographic and physical characteristics of African women football players participants at the 2020 COSAFA Women's tournament (n = 40)

Variable	Score
Age (years)	24 [20.3; 27]
Height (m)	1.60 [1.57; 1.65]
Mass (kg)	58 [55; 65]
BMI (kg.m^{-2})	22.3 [20.5; 24.6]
Dominant leg	
Left	5 (12.5)
Both	7 (17.5)
Right	28 (70)
Playing position	
Goalkeeper	2 (5)
Defender	11 (27.5)
Midfielder	13 (32.5)
Striker	14 (35)
Skill level	
Semi-professional	1 (2.5)
Professional	13 (32.5)
Amateur	21 (52.5)
Not specified	5 (12.5)
Football participation (years)	10 [7; 13]
Football competition (years)	7 [4; 10]
Football training last 0 to 3 months (hrs/week)	8.5 [6; 11.5]
Football training last 4 to 12 months (hrs/week)	10 [10; 12]
Football training last 13 to 24 months (hrs/week)	10 [10; 16]
History of injury	
Yes*	31 (77.5)
Head/face	1 (3.2)
Wrist/hand	1 (3.2)
Torso	2 (6.4)
Ankle	2 (6.4)
Shoulder	4 (12.9)
Foot/toe	5 (16.1)
Hip/thigh	7 (22.6)
Knee	9 (29.0)
No	7 (17.5)
Not specified	2 (5)
Limb girths (cm)	
Upper arm	25.8 [24; 26.8]
Abdomen	73.0 [69.5; 75.3]
Hip	96.5 [91.8; 101]
Thigh	51.8 [46.8; 55]
Calf	34.3 [32; 36]

* Some participants reported more than one injury; Dominant leg, playing position, skill level, and history of injury are expressed as n(%). The remaining variables are expressed as median [Q1; Q3].

half of the participants (n = 21; 52.5%) described themselves as amateur level players and had participated in football for 10 [7; 13] years and football competitions for 7 [4; 10] years. A history of injury was reported by 77.5% (n = 31) of players. No differences in baseline characteristics: age (p = 0.83); height (p = 0.72); weight (p = 0.40), BMI (p = 0.37), and amount of football training in the preceding 24 months were observed between amateur and professional players. Therefore, they were not separated for further analysis. Additionally, no differences in baseline characteristics were noted between players who were left or right side dominant and most of the players were right hand (87.5%, n = 35) and leg (70%, n = 28) dominant, the musculoskeletal assessment results on the right upper or lower limbs were taken for analysis.

Active joint range of motion (AROM), sit and reach, lumbar flexion and extension and Thomas test values are presented in Table 2. There were no significant differences between amateur and professional players for all musculoskeletal assessments; modified Thomas test (p = 0.75), weight bearing lunge test (p = 0.09), sit and reach scores (p = 0.16).

Table 2. Musculoskeletal assessments and muscle endurance scores for the upper and lower limbs among African women football players participants at the 2020 COSAFA Women's tournament (n = 40)

Test	Score median [Q1;Q3]
Active knee extension (°)	–3 [–4; –1]
Thomas test (°)	–3 [–2; –6]
Active shoulder Internal rotation (°)	75 [69; 81]
Active shoulder external rotation (°)	84 [80; 95]
Active hip internal rotation (°)	18 [13; 37]
Active hip external rotation (°)	15 [12; 20]
Weight bearing lunge (cm)	9 [8; 11]
Sit and reach (cm)	14.15 [10; 19.8]
Active lumbar flexion (cm)	9.5 [7.5; 11]
Active lumbar extension (cm)	5.8[3; 9]
Modified push-ups_30s (n)	18.5 [12; 23.5]
Modified push ups_60s (n)	20.5 [0; 30.5]
Squats_30s (n)	16 [14; 19.5]
Squats_60s (n)	28 [30; 38]
Prone elbow plank (s)	46.2 (30.6; 64.5]

The number of push-ups at 30s predicted the number of push-ups at 60s (p < 0.001) and players with an injury history performed fewer push-ups at 60s (p = 0.01). However, this was not significant when adjusted for age, mass, skill level, years of training in the sport, or hours of training in the preceding three (3) months. The number of squats a player could perform in 60s was not predicted by their hip (p = 0.75), thigh (p = 0.08) or calf (p = 0.17) circumference. Additionally, the player's abdominal circumference did not predict the amount of time spent in the prone plank (p = 0.28). Similarly, abdominal girth did not predict number of squats at 30s (p = 0.16) or 60s (p = 0.50). The number of squats at 60s was not influenced by hours of training per week in the preceding 3 to 24 months (p = 0.79), age (p = 0.86), height (p = 0.24), weight (p = 0.16), skill level (p = 0.57) or previous injury (p = 0.06). There was no relationship between the amount of time for the prone plank and history of injury (p = 0.08) even when adjusted for age, mass, height, skill level, years of experience in sport and hours of training in the preceding 3 months. No differences between amateur and professional players were noted in the muscle endurance scores for push-ups (p = 0.99), prone plank (p = 0.55) or squats (p = 0.57).

The median [Q1; Q3] FMS™ score was 12 [10; 13]. None of the players scored a perfect total; the minimum score obtained was 2 and the maximum score was 15. Most players (n = 27, 68%) could not execute a proper deep squat; only 32% (n = 13) performed a proper deep squat (Table 3). Similarly, 28% (n = 11) of athletes performed the hurdle step with proper form. Most players, 70% (n = 28), were able to perform the in line lunge properly. Further, 58% (n = 23) of the athletes were able to perform the straight leg raise and the stability push-up with proper form. Most players scored poorly in the shoulder mobility domain with 73% (n = 29) scoring ≤1. There were no differences between the total FMS™ scores of professional and amateur players (p = 0.91). FMS™ total score was influenced by a history of injury: those who had previous injury had lower FMS™ scores (p = 0.02). However, it was not influenced by age (p = 0.10), height (p = 0.07), mass (p = 0.06), skill level (p = 0.44) or hours of training in the previous 3 months (p = 0.77), 12 months (p = 0.93) or 24 months (p = 0.19).

Table 3. Individual FMS™ scores* for African women football players participants at the 2020 COSAFA Women's tournament (n = 40)

FMS™ domain	0 n(%)	1 n(%)	2 n(%)	3 n(%)
Deep squat	3 (7.5)	6 (15)	18 (45)	13 (33)
Hurdle step	3 (7.5)	1 (2.5)	25 (63)	11 (28)
In- line lunge	3 (7.5)	2 (5.0)	7 (18)	28 (70)
Straight Leg Raise	3 (7.5)	1 (2.5)	13 (33)	23 (58)
Shoulder mobility	3 (7.5)	26 (65)	7 (18)	4 (10)
Stability push up	3 (7.5)	1 (2.5)	13 (33)	23 (58)

The number of football players who scored each score for every domain are presented as absolute figures (n) and percentage (%) of total.
*The scores for the rotary stability test are not included because the investigators (inexplicably) omitted this test.

No associations were observed between shoulder internal and external AROM and FMS™ scores for stability push-up, shoulder mobilisation and the FMS™ total score (p > 0.05). The ankle dorsiflexion AROM was not associated with FMS™ scores in the squat (p = 0.93), or in line lunge (p = 0.15). However, ankle dorsiflexion AROM was associated with the FMS score in the hurdle step (p = 0.01). No associations were observed between hip internal (p = 0.77) and external rotation (p = 0.88) AROM and FMS™ scores in the squat, hurdle step, or in line lunge. Additionally, no associations were noted between sit and reach scores and straight leg raise (SLR) (p = 0.93); no associations were noted between active lumber flexion (p = 0.72), extension (p = 0.44) and SLR scores. Furthermore, FMS™ squat scores were independent of thigh (p = 0.547), calf (p = 0.91) or hip (p = 0.70) girth and FMS™ stability push scores were not influenced by upper arm girth (p = 0.70). However, players who scored high on the FMS™ squat also did more squats in 60s (p = 0.03).

Knee extension AROM was not associated with injury (p = 0.29) but not when adjusted for thigh girth (p = 0.04). Hip external rotation AROM was associated with history of previous injury (p = 0.01) but not after adjustment for age, height, mass, leg dominance and hip girth. Sit and reach values (p = 0.15) and ankle dorsiflexion AROM values (p = 0.66) were not associated with history of injury.

Discussion

The main findings of this study were that, in a cohort of African women football players, most players presented with a reduced range of motion in the shoulder, hip and ankle. Additionally, the players could perform on average 20.5 push-ups in 60 s and could hold the prone elbow plank for an average of 46.2 s. Furthermore, 67% of the players could not execute a proper deep squat, 72% could not execute a proper hurdle step, 70% performed the in-line lunge properly, and 73% scored ≤1 on the shoulder mobility domain. Additionally, lower FMS™ scores in certain domains were associated with lower muscle endurance in the corresponding muscle region. These findings suggest a high intrinsic risk of injury in this cohort.

Players in this cohort presented with lower AROM, in particular hip internal and external rotation, than reported in other football cohorts (Mentiplay et al., 2019; Mosler et al., 2017). A correlation between decreased joint ROM and increased risk of injury has been shown previously (Tak et al., 2016). Hip AROM is key in football performance as it determines kicking and inside passing, which are central actions of the game, and require considerable hip AROM. Additionally, the importance of hip AROM is further emphasised by its association with anterior cruciate ligament (ACL) injury risk and prevention programs (Bedi et al., 2016; Omi et al., 2018). However, this finding is equivocal (Tak et al., 2017a; Whittaker, Small, Maffey, Emery, 2015). These observed differences could be because of heterogeneity in measurement techniques used in different studies (Whittaker et al., 2015; Li et al., 2015; Tak et al., 2017b), which limits direct comparisons and ought to be considered in the interpretation of the results. In particular, measuring hip rotation ROM in the seated position has been shown to yield lower values than in prone lying (Simoneau, Hoenig, Lepley, Papanek, 1998) and may also explain the low values obtained in our cohort.

Upper limb, core and lower limb muscle endurances in this cohort were lower than previously reported in the literature (Abdallah et al., 2019; Mentiplay et al., 2019). However, our results are similar to results in cohorts of African women basketball players (Mtsweni et al., 2017) and South African women football players (Williams et al., 2019). Previously, core stability, neuromuscular core and core proprioception have been associated with injury risk, while the relationship between core endurance and injury is conflicting (De Blaiser et al., 2018). However, more recent work demonstrates a strong association between core endurance and (prospective) development and frequency of overuse and lower limb injuries (Abdallah et al., 2019; De Blaiser, De Ridder, Willems, Vanden Bossche, Danneels, Roosen, 2019). Low core muscle endurance may lead to non-contact injuries directly through inability to produce sufficient force to maintain trunk stability once the muscles fatigue, as would be observed in the second half or extra time of a football match (Zazulak, Cholewicki, Reeves, 2008). This limits the body's ability to control its centre of mass forcing the lower limbs to compensate, making one susceptible to injury (Abdallah et al., 2019). Additionally, core muscle fatigue also leads to altered landing biomechanics, which may contribute to altered lower limb movements during play and hence injury (Read, Oliver, De Ste Croix, Myer, Lloyd, 2018). Therefore, targeted muscle endurance training should be an integral part of injury prevention strategies in cohorts such as ours (McCall, Dupont, Ekstrand, 2016).

The observed low FMS™ scores suggest poor fundamental movement pattern quality. This is supported by our finding that players with higher FMS™ scores in certain domains had greater muscle endurance in the corresponding muscle region, which suggests that proper form leads to improved performance measures. Poor fundamental movement patterns suggest muscle weaknesses in some muscle groups which leads to compensatory movements and may lead to increased injury risk (Cook et al., 2006b, 2006a; Eckard et al., 2018). Indeed, low FMS™ scores have been associated with increased risk of injury in some studies (Šiupšinskas, Garbenytė-Apolinskienė, Salatkaitė, Gudas, Trumpickas, 2019) though others have not (Schroeder, Wellmann, Stein, Braumann, 2016). Furthermore, evidence is available to recommend against the FMS™ as a standalone tool for injury risk analysis in football (Newton et al., 2017). The FMS™ is, however, a relatively affordable tool, easy to administer, and score, which would make it accessible to most practitioners in low- and middle-income environments to assess injury risk when used in combination with other tools. Additionally, results of the FMS™ can still be useful to design strength and conditioning programs during preseason in those athletes with identified deficiencies (Newton et al., 2017).

Overall, players in this cohort presented with considerable intrinsic risks for injury. These are of concern on their own, but more so when experienced in combination with a multitude of extrinsic risk factors such as poor training environments (Chalmers et al., 2011). While broader structural and administrative constraints may explain the extrinsic risk factors for African women football teams, the risk factors observed herein are modifiable at a personal/team level, mainly through strength and conditioning programs (Brooks, Fuller, Kemp, Reddin, 2006). These strength and conditioning programs can be done at fairly low or no cost and even with minimal or no equipment. Therefore, there is a need to develop systematic models to screen African women football players and subsequently develop context relevant programs to reduce injury risk. However, there is a shortage of qualified personnel to work with women football teams (Geertsema et al., 2021). It is, however, noteworthy that existing coach led injury prevention programs such as FIFA 11+ have been demonstrated to reduce injury risk parameters (Sadigursky et al., 2017); therefore, their role in injury prevention should be re-emphasised especially in resource limited cohorts.

This study is not without limitations. Firstly, there is a risk of non-participation bias in our cohort; less than 25% of the players at the tournament agreed to participate. It is possible that those who participated in the study were the ones who had impairments in movement quality and would thus be drawn to such a study. Secondly, more sensitive tests could have been used to collect the data in this study. However, in resourced constrained settings, the methods used are easily accessible and repeatable for monitoring football players in this regard. Thirdly, while conducting the FMS™ testing, the rotary stability test was omitted. Hence, we have an incomplete view of composite FMS™ scores. However, we did conduct the prone elbow bridge to assess core endurance; hence we can, to some extent, extrapolate on the stability of core musculature from these values. Further, the measurements taken in this study could have been repeated thrice to ascertain intra-tester reliability. However, as this study was conducted during a tournament, we had limited time with the participants in between their training, match, and recovery schedules. Lastly, this is a cross sectional study of a small sample of participants; therefore, these results should be generalised to African women football players with caution.

In conclusion, African women football players in this cohort presented with reduced joint range of motion, low muscle endurance, and low FMS™ scores, which suggests high intrinsic risk of injury. Therefore, there is a need to develop systematic models to screen African women football players and subsequently develop context relevant programs to reduce injury risk. In particular, proper strength and conditioning programs should be instituted in this population to improve muscle endurance, movement quality and, ultimately, reduce injury risk. However, as there is a shortage of qualified personnel to work with women football teams, the role of existing coach led injury prevention programs in injury prevention should be re-emphasised.

Perspectives

Numerous studies on intrinsic risk factors in sport have been conducted in female athletes. However, few of these are in women athletes from low- and middle-income settings. This limits the development of context relevant, holistic injury prevention protocols that account for their particular biopsychosocial circumstances. This study showed that this cohort of African women football players present with considerable (modifiable) intrinsic risk factors for injury. Biology does not exist in a vacuum; therefore, any corrective or preventative strategies such as strength and conditioning programs ought to be considered within these players' context of concomitant extrinsic risk factors for injury such as (lack of) proper equipment, infrastructure, qualified personnel, as well as prevailing negative socio-cultural norms towards strength training in female athletes.

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Data availability statement

Individual, de-identified data collected in the study will be made available following publication, for aims approved in the proposal and upon reasonable request to the corresponding author on nonhlanhla@ntombisport.com. These data will be available for 3 years after publication.

Patient consent for publication

Not required.

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