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Relationship Between Physical Fitness Variables and Playing Ability Among Handball Players in Senior High Schools in Central Region, Ghana

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Abstract: The purpose of the study was to investigate the relationship between physical fitness variables and playing ability of male handball players in Senior High Schools in the Central Region of Ghana. The population consisted of 960 male handball players in five zones from 64 Senior High Schools in Central Region. Out of this, 156 of the players were purposively sampled for the study. The ages of participants ranged between 15 and 22 years. Data was collected on physical fitness variables and handball playing ability. Mean and standard deviations were calculated for each of the selected variables and compared with normative data. The inter-relationship among the selected physical fitness variables and handball playing ability were calculated using Pearson product-moment correlation. Stepwise method of multiple regression was used to find out which predictor variables had the highest correlation with the criterion variables. The results revealed that physical fitness variables (speed, arm strength, leg strength, flexibility, agility, cardiovascular endurance) had significant relationships with playing ability of handball players in Schools and Colleges in the Central Region of Ghana at $p < 0.05$. It is therefore recommended that coaches or trainers use data on physical fitness and handball playing ability as criteria for selecting players at the SHS level into their handball teams and also develop their training programmes by emphasising on related physical fitness variables to improve playing performance in handball at the SHS level.

Keywords: Speed, Strength, Flexibility, Agility, Cardiovascular Endurance, Physical Fitness

1. Introduction

Handball is a game played by more than 50 million people around the world [21]. The game handball, also known as field handball or team handball, is touted as a fast, dynamic game where the players need to be physically fit to work as a team. The game requires the smallest amount of equipment and 14 people can play at once. Generally, a standard match consists of two periods of 30 minutes, and the team that scores more goals wins. It is considered as a fast, aggressive and vigorous sport and it builds endurance, skills and keeps one fit and strong [40].

Sports science plays an important role in handball performance. The game is a team-based sport and requires a substantial amount of external and internal factors like anthropometric, physical, psychological and physiological characteristics to play at high level competitions [30]. Anthropometry is the study of the human body parts taken into consideration the composition, magnitudes and dimensions of bone, muscle and adipose tissue [31].

Physical fitness is the capacity of a person to function steadily and smoothly when a situation arises [30]. Anthropometric measurement is an important key to human movement [12] and has led to many anthropometrists conducting studies to assess physical characteristics of people. Kinanthropometry is a quantitative description

between human structures and functions [34]. According to According to Devaraju and Needhiraja [11], this is explained by the measurement and analysis of age, body size, shape, proportion and composition as they relate to the total body functions. Researchers have shown that body structure and morphological variables are crucial determinants of playing ability in many sports disciplines and that body composition (body fat, body mass, muscle mass) and physique can significantly affect performance [24]. According to Devaraju and Needhiraja [25] revealed that anthropometric variables are relevant for handball playing ability because the game involves human contact that requires a specific physique, especially in the selection of handball players.

Playing ability is one's capability to execute the actual motor task. These playing abilities are the skill exhibited during play. In handball, these skills may include shooting, passing or throwing and dribbling. Handball has few tests available to evaluate the skill performance of handball players [23]. These tests include Front Shoot - to measure Shooting Ability, Accuracy Throw - to measure Throwing Ability, Speed Pass - to measure Passing Ability and Agility Dribble - to measure Dribbling Ability. Most of these abilities, according to Kangane [23] are usually tested using standardized measures. In high motor performance sports like handball, emphasis is always placed on the physical conditioning of the players and this requires physical and mental adaptation especially in modern handball [31]. The modern handball game requires high intensity motor activity on the part of the players. Basic and specific motor abilities and cardio-respiratory capacities such as strength, speed, agility, endurance and coordination are paramount for the performance of specific motor assignment and space orientation in the playing of handball [11].

Handball requires aerobic and anaerobic capacities. This is demonstrated in motor abilities, sprinting, jumping and throwing velocity as physical activities that present an important aspect of the game and contribute to high performance [11]. These specific characteristics of handball players demand an effective participation in activities that require good aerobic and anaerobic response to promote excellent performance especially leg and arm power, sprint velocity and kinesthetic feeling of the ball [5]. Handball players can do well technically and tactically only if they possess high level of anaerobic metabolic adaptation [35]. Handball is an endurance game and players need physical fitness such as speed, agility, flexibility and strength to augment their performance.

It is evident that handball requires that the performer is able to run, jump, throw and catch balls and these are natural and specific skills. Visnapuu and Jürimäe [43] reported that specific hand anthropometric parameters, finger lengths and perimeters of the hand significantly correlated with the maximal handgrip strength, which has direct bearing on accuracy of different shots, especially in games like handball and basketball. Gopinathan and Helina [17] determined the relationship of anthropometric and physical fitness variables with handball performance. It was revealed that height, weight, arm length, leg length, palm span and sum of four skin-folds and physical fitness variables of speed, agility, explosive power, shoulder strength, and strength endurance have significant relationship with handball performance. Singh et al. [38] and Chauhan [8] in their studies also made it clear that these anthropometric and physical fitness variables contribute to the high performance of handball players in the area of dribbling, passing and shooting.

Singh and Ram [40] conducted a study on Inter-University level 200 male handball players of age range 18-25 years with 27 anthropometric measurements and 6 physical fitness components as independent variables as against cumulative score of two skill tests (9-meter front throw and overhead pass) as dependent variable. The study revealed that body weight and linear measurements (standing height, sitting height, total arm length, upper arm length, leg length, thigh length, lower leg length, hand length and handbreadth), body diameter measurements (elbow and shoulder diameters), body girth measurements (shoulder, chest and abdomen girths), skin-fold measurements (biceps, triceps and sub-scapular skin-folds); body composition variables (lean body mass and fat weight) and physical fitness components (speed, agility, arm and leg strength) had significant correlations with playing ability of handball players. The multiple correlation of the 9 independent variables taken together with playing ability were found to be highly significant and can be used in the prediction of handball playing ability.

Several other studies [6, 7, 9, 10, 28, 43] also established that there are human attributes and abilities that contribute to the success of handball players. However, most of these studies were conducted using elite players as samples and were mostly conducted in Europe. Other studies in Nigeria concentrated on university athletes [2, 12]. Using such studies to compare performance of high school students might be problematic because of differences in areas such as maturation, level of play and experience. Coaches or selection authorities need baseline data on handball players to ascertain those that contribute to playing ability. These measurable variables of anthropometric and physical fitness characteristics of the handball players are fundamental factors for the selection and development of handball players [16, 40].

1.1. Statement of the Problem

There is stock of knowledge about the contribution of scientific development in the training of handball players in most advanced countries. Scientific and result oriented investigations, analysis as well as assessment of individual playing abilities help coaches and physical educators to select players at early ages and train them accordingly for their achievement at various levels. Globally, there have been several studies that deal with the appropriate body stature [7, 9, 10, 15, 18, 28, 39, 44] and physical fitness [19, 20, 26] of handball players.

Unfortunately, in Ghana, literature available turns to suggest that there is no study on physical fitness variables and playing ability of handball players at any level. The

existence of such data on physical fitness variables and playing ability of handball players especially at the youth level will serve as a basis for coaches to select future handball stars. The lack of such literature in Ghana renders handball coaches with no scientific baseline knowledge to assess the performances of their teams. The coaches tend to rely on other factors not scientifically proven**.** Michalsik et al. [27] spelt out variables essential for excellence in handball by describing the profile and physiological demands of a handball team. To the best knowledge of these researchers, not much has been done in investigating the physical fitness variables and playing ability of handball players in particular at the Senior High Schools Handball Game Competitions in Ghana.

1.2. Purpose of the Study

The purpose of the study was to investigate the relationship between physical fitness variables and playing ability among handball players of Senior High Schools in Central Region, Ghana.

1.3. Research Questions

1. What are the physical fitness variables of handball players in Senior High Schools in the Central Region of Ghana?
2. What are the levels of playing ability parameters of handball players in Senior High Schools in the Central Region of?

1.4. Research Hypothesis

There will be significant relationships between selected physical fitness variables and playing ability among Senior High School handball player in the Central Region of Ghana.

2. Methodology

The study employed correlational research design with playing ability in handball as the dependent variable and selected physical fitness components as independent variables. The design sought to measure and compare the playing ability of all players whose teams came either first or second in their respective zones. A sample size of 156 male handball players were purposively selected from a population of 960, aged between 15-22 years, who played for their schools in their respective zonal games during the 2016 edition of the Central Region Senior High School Games Competition. Purposive sampling technique was used because these players were within an age category and also possess the characteristics for the study [13]. Data was collected using existing instruments which were adopted from Kangane [23] and Padamraj [33]. The following instruments were used to collect data for the physical fitness; speed by 50 metre run (seconds), arm strength by hand grip dynamometer (Kilogram), cardiovascular endurance by 12 minutes run (metres), flexibility by Sit-and-Reach Test (Centimetres), agility by Shuttle run (10x4metres) (seconds) and leg strength by Standing Broad jump (metres). Data from playing ability in handball were obtained using the following; shooting by front shot test (points), throwing accuracy by accuracy throw test (points), passing by speed pass test (point) and dribbling by agility dribble test (seconds). Eight specially trained Master of Philosophy (Physical Education) students, three handball coaches and three physical education experts assisted in collecting data on different items. The assistants were oriented with training in the procedures of accurate measuring and recording of scores in each test for two days at the Department of Health, Physical Education and Recreation Gymnasium. After the training, assistants were asked to measure the performance of 15 participants in each specified test in the pre-testing. The pre-testing enabled the researchers to check the working state of the instruments, become acquainted with the requirement of the instruments for the study and get the research assistants familiar with all the standardized tests, equipment and procedure for the main study. The research instruments were standardized with their respective psychometric properties. Furthermore, measurements for the physical fitness and playing ability variables taken as directed by Baumgartner et al. [3] in order to further establish the reliability. The reliability of the instrument was calculated after the test and measurement of physical fitness and playing abilities. All the instruments required for the collection of the data were obtained from reputed suppliers of standard equipment procured by one Lecturer at the Department of Health Physical Education and Recreation, University of Cape Coast. However, re-calibration of the instruments was done through a test re-test to ensure their standards are maintained.

Before the period for data collection, the entire proposal with an introductory letter from the department was sent to the Ethical Review Board of the University of Cape Coast for approval, which was granted. Permission was also sought from the Heads and Physical Education Tutors of all the 10 schools used for the study. When permission was granted, dates were set for data collection. Two days were used for data collection. Participants were made to sign the informed consent form in the presence of their coaches as witness before data collection. All the anthropometric measurements were taken in the morning. All the measurements where sides were involved were taken on the right side of individuals for consistency. The assistants recorded the selected physical fitness and playing ability measurements on the score sheet provided for data collection. In an attempt to get the full support from the participants, the researchers explained to them the purpose of the study, tests to be administered and procedures of the test. Rehearsal trials were conducted to help the participants understand the methods of testing.

Data for the study was collected on a continuous scale for all the variables such as physical fitness and playing ability. The first step of data analysis in this study was to check for accuracy, consistency and completeness. Each column of the score sheet for data collection was checked for accuracy and consistency of the recording of the items on the instrument. The score sheet was checked for comprehensiveness of the

recordings. After editing, a template was developed and used to create a data analysis matrix on the computer, as well as code responses to the items on the score sheet. After coding, the data was then entered into the computer analysis matrix developed with the computer software, Statistical Package for the Social Services (SPSS) version 21. Before the analysis, the data was cleaned to check for errors and consistency in entering and recording. The data was also screened to check normality and homogeneity.

The data was analysed to find out how well physical fitness variables correlate with playing ability of handball players. Mean and standard deviations were calculated for each of the selected variables. The result was compared with other normative data on selected physical fitness and handball playing ability to answer research questions one and two. These normative statuses were referenced data points established through research to serve as baseline for comparison for both athletes and non-athlete of a particular age range. The mean was useful in determining the overall trend of a data set or providing a rapid snapshot of the data, whiles the standard deviation was useful for quick determination of dispersion of data points [1].

The inter-relationship among the selected physical fitness variables and handball playing ability were calculated using Pearson product-moment correlation coefficients to test hypothesis one. This was applicable since both dependent (playing ability) and independent variables are continuous in nature [4]. The analysis was done using Statistical Package for the Social Science (SPSS) software version 21.

3. Results and Discussions

Research Question 1: What are the Physical Fitness Variables of Handballers in Senior High Schools in Central Region?

Results of physical fitness variables of participants are presented in Table 1. This data is compared with normative data.

Table 1. *Descriptive Statistics on Physical Fitness Variables of Participants.*

Variable	M	SD	Normative Status	Source
Speed	6.50	± 0.50	Excellent	Kangane [23]
Arm strength	67.00	± 3.60	Excellent	
CVE	2632.90	± 136.70	Excellent	
Flexibility	40.50	± 4.20	Good	
Agility	9.20	± 0.30	Excellent	
Leg strength	2.50	± 0.15	Excellent	

Table 1 showed the mean values of the physical fitness variables (speed, arm strength, cardiovascular endurance, flexibility, agility and leg strength) of the participants (N=156) The mean values of the participants' speed was 6.50 ± 0.50 in seconds; arm strength of 67.00 ± 3.6 in kilogram; cardiovascular endurance of 2632.90 ± 136.70 in metres flexibility of 40.50 ± 4.20 in centimetres, agility of 9.20 ±0.30 in seconds and leg strength of 2.50 ± 0.15 in metres. Comparing results of participants on physical fitness variables to the normative status of handball players of the same age category as reported by Kangane [23], revealed that the participants in the current study have between good and excellent physical fitness components that are appropriate for good handball performance. This implies that handball players in Senior High Schools in Central Region possess the right physical fitness status for optimal performance in their competitions**.**

Research Question 2: What is the Level of Playing Ability Parameters of Handballers in Senior High Schools in Central Region?

The descriptive statistics showing selected playing ability of participants are presented in Table 2.

Table 2. *Descriptive Statistics Showing Playing Ability of Participants.*

S/N	Variable	M	SD	Range	Normative	Source	status
1	Shooting	30.90	±3.00	23 – 38	Excellent	Kangane [23]	
2	Throwing accuracy	24.30	±1.40	20 – 27	Excellent		
3	Passing	37.70	±3.80	29 – 46	Excellent		
4	Dribbling	4.50	±0.40	4.17– 6.15	Good		

N= 156.

Table 2 summarised the mean values of performance of 156 participants in shooting, throwing accuracy, passing and dribbling in handball. The mean values of the participants' shooting was 30.90 ± 3.00 in points, throwing accuracy of 24.30 ± 1.40 in points, passing of 37.70 ± 3.80 in points and dribbling of 4.50 ± 0.40 in seconds. Comparing this data with the normative data of Kangane [23], it shows that participants possessed adequate amount of skill at the regional level. More than half of participants were found to be in the excellent category, which is a good attribute of the participants, which should be taken into consideration during selection and training schedules. In order to find out the inter-relationship between the dependent variable (handball playing ability) and independent (physical fitness) variables, Pearson product-moment correlation coefficients and p-values were calculated.

Hypothesis 1: There will be Significant Relationships between Selected Physical Fitness Variables and Playing

Abilities of Handball Players in Central Region, Ghana.

Table 3 revealed the correlations between playing ability (shooting, throwing accuracy, passing and dribbling ability) and fitness variables (speed, arm strength, leg strength, flexibility, agility and cardiovascular endurance). Speed had a negative significant relationship with shooting ability (r= -0.87), throwing ability (r= -0.68) and passing ability (r= -0.57). However, with dribbling ability, speed showed a positive significant correlation (r=0.61). Arm strength had a positive significant relationship with shooting ability (r=0.88), throwing accuracy (r=0.55), passing (r=0.56) and a negative signification relationship with dribbling [(r = -0.87), p<0.05]. For leg strength, the table revealed a moderately negative significant relationship with shooting ability (r= -0.41), throwing accuracy (r= -0.42) and a low negative significant relationship with passing (r= -0.38) and an insignificant relationship with dribbling [(|r=0.13) p<0.05].

Table 3. *Results Showing the Correlation between Handball Playing Ability and Selected Physical Fitness Variable of Participants.*

Variable		Shooting ability	Throwing accuracy	Passing ability	Dribbling ability
Speed	R	-0.87	-0.68	-0.57	0.61
	Sig	0.00	0.00	0.00	0.00
Arm strength	R	0.88	0.55	0.56	-0.87
	Sig	0.00	0.00	0.00	0.00
Leg strength	R	-0.41	-0.42	-0.38	0.13
	Sig	0.00	0.00	0.00	0.09
Flexibility	R	0.75	0.40	0.46	-0.93
	Sig	0.00	0.00	0.00	0.00
Agility	R	-0.69	-0.38	-0.43	0.96
	Sig	.000	.000	.000	0.00
CVE	R	-0.11	-0.18	-0.11	-0.07
	Sig	0.16	0.02	0.18	0.41

r = Pearson correlation sig = p-value N= 156
Source: Field survey, Authors (2017).

The results on flexibility showed a high positive significant relationship with shooting ability (r= = 0.75) and a negative significant relationship with dribbling (-0.93). It had moderate significance with throwing accuracy (r=0.40) and passing [(r=0.46) p<0.0]. Agility had a high positive significant relationship with only dribbling (r = 0.96, p<0.05), moderate positive relationship with shooting (r = 0.69, p<0.05) and passing (r=0.43p<0.05) and a low positive relationship with throwing accuracy (r=0.38p<0.05). Cardio respiratory endurance had a low negative significant relationship with throwing accuracy (r = -0.18, p<0.05). However, there was no significant relationship with shooting ability (r= -0.11, p<0.05), passing (r= -0.11, p<0.05) and dribbling (r = 0.07, p>0.05).

The findings indicated that most of the fitness variables of the participants (speed, arm strength, leg strength, flexibility, agility and cardio respiratory endurance) had significant relationship with playing ability of handball players. The findings on speed were supported by the position of [40] and [16] that speed highly correlates with playing ability of handball players. This implies that every handball player requires better speed work in different game situations to succeed. The players with movement speed demonstrate explosive runs; maneuver quickly to defend at different corners of the court, which goes a long way to achieving perfect timing on court. Speed correlate better with different skills such as shooting, passing, dribbling and throwing accuracy [26].

The findings on arm strength is in line with that Gaurav and Singh [14] that concluded that strength in the arms of handball players have a greater influence on the playing ability of handball skill. Stronger upper extremity is required for faster manipulations of the body in a handball game. The findings on leg strength also affirms the position of Rousanoglou et al. [36]. They contend that leg strength affects playing ability of handball players especially in relation to their playing position. Leg strength and arm strength among other physical fitness variables demonstrated greater correlation with handball performance. While arm strength is a major determinant of throwing velocity that guide the accuracy of passing and shooting, strong leg strength helps players to increasing stride length and taking-off strongly from 9 or 7 meters in the case of executing the jump shot to score a goal in handball. Arm strength contributes to maximum force generation during shooting and accurate passing to partners while leg strength enables the players to maneuver their way in between opponents and on the court towards the goal.

Agility and flexibility had been well documented in literature as fitness variables essential to muscle coordination, injury prevention and force generation, needed for good wrist power, shoulder movement, leg muscular strength, upper and lower extremities, which contribute to better exhibition of the playing skill. The findings of Kalidasan [22] reported that motor abilities, a factor of movement frequency rate, which is linked with the ability of ball manipulation, was perceived to predict significantly Handball players' performance. Monica et al. [29] affirmed that agility had a greater influence on the playing ability of handball players in their study. The duo (i.e. agility and flexibility) have serious implications on safety from injury to the body. The findings on cardio respiratory endurance support the position of Mohammed et al. [28] that elite handball players scored considerably better on cardio respiratory endurance while Dominic [12] found that university handball players have better cardio respiratory endurance capacity than their basketball counterparts. This could be because of the duration, dimension of the court and speed of movement during handball games and the less stoppage of the game due to whistle interruption. Cardiorespiratory endurance is essential for handball playing in equipping the player physiologically to cope with the stress and endurance for longer periods. Cardio respiratory endurance helps the players to adjust and recover from fatigue. Therefore, there is the need to design training programmes, which would specifically develop these imperative fitness components.

Main Finding

The study found out that participants demonstrated good to

excellent levels and abilities in both the physical fitness variables (independent variable) and playing ability (dependent variable) when compared with the normative data reported by Kangane [23] and Padamraj [33]. The study further revealed that most of the fitness variables of the participants (speed, arm strength, leg strength, flexibility, agility and cardio respiratory endurance) had significant relationship with playing ability of the SHS male handball players.

4. Conclusions and Recommendations

4.1. Conclusions

Based on the finding of the present study, it was concluded that:

1. Handball players in senior high schools in central region possess the right physical fitness status for optimal performance at that level of competition.
2. Skill levels of these handball players could serve as criteria for future selection of handball players to represent the region.
3. Physical fitness variables such as speed, arm strength, leg strength, flexibility, agility and cardio respiratory endurance relate to playing ability of handball especially among adolescent players.

4.2. Recommendations

1. Coaches or trainers can use data on physical fitness and handball playing ability as criteria to select athletes into their handball teams.
2. On the basis of results, coaches and trainers may develop their training programmes emphasising on related physical fitness variables to prove to playing performance in handball at the SHS level.

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