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Performance Assessment of Inter University Handball Female Players in Relation to their Anthropometric and Physical Fitness Variables

Amarjit Singh Gill[1], Kanwaljeet Singh[2] and Baljinder Singh Bal[3]
[1]R.K. Arya College, Nawanshahar, Punjab, INDIA
[2]Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, INDIA
[3] Guru Nanak Dev University, Amritsar, Punjab, INDIA

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Abstract

The aim of this study is to find out the significant differences of performance assessment of inter university handball female players in relation to their anthropometric and physical fitness variables. For the purpose of the present study, One Hundred Two (N=102), Female University Level Handball Players between the age group of 18-25 years (Mean ± SD: age 23.15±1.98 years, height 176.35±5.17cm, body mass 67.87±7.15kg) were selected. A purposive sampling technique was used to select the subject for the study. The players in the teams who participated in the Inter-University handball women championship of Punjab University Chandigarh, Punjabi university Patiala, Guru Nanak Dev University Amritsar, Kurkshetra University Kurkshetra, M.D University Rohtak, Delhi University Delhi, Himachal Pardesh University Shimla and P.A.U University Ludhiana were considered. The results of the regression analysis were used to draw out the equations of the identified anthropometric, motor fitness and motor skill variables. Person's Product Moment Coefficients of Correlation (r) were computed to see the relationship of playing ability with anthropometric, motor fitness and motor skill variables. Coefficient of Variation (C.V.) was also calculated as standard deviation as percent of the arithmetic mean. The results revealed significant differences were found the anthropometric variables namely age, height biacromion width arm length, upper arm length, leg length, calf circumference, sitting height, supra-iliac skin fold were found to be positively significant in relation to the performance of handball players. The motor fitness variables namely speed, agility, power of arm, power of legs, endurance and left handgrip strength were found to be significantly related to the performance of handball players. Dribbling, passing handball throw, dominant hand throwing ability, non dominant hand throwing ability, throwing accuracy and defensive movement motor skill variables were found to be significantly related to the performance of handball players.

Keywords: Inter University, Handball, Anthropometric and Physical Fitness Variables.

Introduction

Sports standard is interrelated with sports culture. According to Daryal Siedentop, the sports culture of America is one of the most highly developed in the world. Ninety eight percent of all Americans participate is sports, read about sports or watch sports on television at least one a week. Seventy percent of adults are sports fans. Spectators' attendance is all times high. Organized sports for children begin as early as at 3 years of age, with an average early entry age of 5-8 years and an average entry age of 11 years for all. Studies also revealed that substantial amount of adipose tissues rendering the work more difficult to perform in endurance activities. However, the degree of excess fat may play an advantageous role, if not a vital one, in some sports. Motor fitness is an inseparable part of sports performance and achievements; its components play a vital role in achieving top-level performance in sports discipline. However, importance of various components of fitness varies with different sports. To Harre[1] for a high level of performance, physical fitness is most important. Therefore, Physical fitness is considered to be the fundamental criteria for developing an efficient system of selection strategy, Baumgartner[2] defines physical fitness as the 'capacity of heart, blood vessels, lungs and muscles to function at optimal efficiency'. Physical fitness is a complex phenomenon, consisting of various factors like power, speed, cardiovascular endurance etc. Of all these, the crucial factor seems to be cardiovascular fitness. Physical fitness is to the human body what fine-tuning is to an engine. It enables us to perform up to our potential. Fitness cam ne described as a condition that helps us look, feel and do our best. More specifically, it is "the ability, to perform daily tasks vigorously and alertly, with energy left over for enjoying leisure-time activities and meeting emergency demands". It is the ability to endure. To bear, to withstand stress, to carry on in circumstances where an unfit person could not continue and is major basis for good health and well- being. Handball game requires a high-level development of physical and motor skill traits so as to give the best possible performance. A player should have appropriate physical structure and body size suitable for this game. This game demands quick, alert and well-coordinated players with great stamina to master its complex skills and situations. The skill must be developed up to the maximum level to get optimum performance with minimum energy expenditure. Uppal[3] and Smith[4] suggested that

anthropometric characteristics have been considered pre-requisites for the game. The height is of special advantage to the player in handball game to receive the ball, to pass the ball and for goal in throw. The advantage of height also has great carryover value for execution of all skills in handball.

Methodology

Selection of Subjects: For the purpose of the present study, One Hundred Two (N=102), Female University Level Handball Players between the age group of 18-25 years (Mean ± SD: age 23.15±1.98 years, height 176.35±5.17cm, body mass 67.87±7.15kg) were selected. A purposive sampling technique was used to select the subject for the study. The players in the teams who participated in the Inter-University handball women championship of Punjab University Chandigarh, Punjabi university Patiala, Guru Nanak Dev University Amritsar, Kurkshetra University Kurkshetra, M.D University Rohtak, Delhi University Delhi, Himachal Pardesh University Shimla and P.A.U University Ludhiana were considered. Under the circumstances total 102 players were considered fit to act as subjects for collection of data. The subjects were purposively assigned into following groups:

Table-1
Total Sample Size (N=102)

Sr. No.	Subjects	Sample
1	Punjabi University, Patiala	14
2	Panjab University, Chandigarh	14
3	Guru Nanak Dev University, Amritsar	16
4	Kurkshetra University, Kurkshetra	14
5	M.D University, Rohtak	12
6	Delhi University, Delhi	12
7	Himachal Pardesh University, Shimla	10
8	P.A.U University, Ludhiana	10

Selection of Variables: A feasibility analysis as to which of the variables/skills could be taken up for the investigation, keeping in view the availability of tools, adequacy to the subjects and the legitimate time that could be devoted for tests and to keep the entire study unitary and integrated was made in consultation with experts. With the above criteria's in mind, the following Anthropometric Variables, Physical Fitness Variables and Skill Variables were selected for the present study:

Statistical Techniques Employed: The results of the regression analysis were used to draw out the equations of the identified anthropometric, motor fitness and motor skill variables. Person's Product Moment Coefficients of Correlation (r) were computed to see the relationship of playing ability with anthropometric, motor fitness and motor skill variables. Coefficient of Variation (C.V.) was also calculated as standard deviation as percent of the arithmetic mean.

Results and Discussion

It showed that age had mean value 23.15, standard deviation 1.98 and coefficient of variation 8.96. Height had mean value 176.35, standard deviation 5.17 and coefficient of variation 2.93. Weight had mean value 67.87, standard deviation 7.15 and coefficient of variation 10.98. Shoulder width had mean value 79.15, standard deviation 5.73 and coefficient of variation 7.24. Biocromion width had mean value 46.18, standard deviation 2.42 and coefficient of verification 5.25. Arm length had mean value 79.20, standard variations 3.55 and coefficient of variation 5.68. Arm length had mean value 79.20 standard variations 4.55 and coefficient of variations 5.33.and coefficient of variation5.33 Upper arm length had mean 37.35 standard deviation 2.70 and coefficient of variation 5.68. Forearm length had mean 29.56, standard deviation 2.70 and coefficient of variation 5.91. leg length had mean 88.26, standard deviation 4.87 and coefficient of variation 5.44. Calf circumference had mean 36.01, standard deviation 3.25 and coefficient of variation 7.40. Sitting height had mean 88.18, standard deviation 2.98 and coefficient of variation 4.30. Supper-iliac skin fold had mean value 11.99, standard deviation 6.19 and coefficient of variation 48.20.Thigh skin fold had mean value 8.69 standard deviation 2.98 and coefficient of variation 35.47. Sub scapular skin fold had mean value 7.29, standard deviation 2.45 and coefficient of variation 34.53. Calf skin fold had mean value 8.35, standard deviation 3.25 and coefficient of variation 37.29. Bicep skin fold had mean value 2.57, standard deviation 0.88 and coefficient of variation 33.96 and tricep skin fold had mean 4.25, standard deviation 1.30 and coefficient of variation 32.78. It is, therefore, evident that the variation in age, height, weight, shoulder width, biacromion width, arm length, upper arm length, forearm length, leg length, calf circumference and sitting height ranged between 2.91 to 10.71 percent according to the values of coefficients of variation. This variation was insignificant while the variation that various skin fold variables had showing more than 30 percent, was significant. This level of variation might have its impact on playing ability.

Table-2
Table showing Mean values of anthropometric parameters

Parameters	Mean	S.D.	C.V.%
Age (years)	23.15	1.98	8.96
Height (cm.)	176.35	5.17	2.93
Weight (Kg.)	67.87	7.15	10.98
Shoulder width (mm.)	79.15	5.73	7.24
Biacromion width (mm.)	46.18	2.42	5.25
Arm length (cm.)	79.20	4.55	5.33
Upper arm length (cm.)	37.35	2.70	5.68
Fore arm length (cm.)	29.56	2.73	5.97
Leg length (cm.)	88.26	4.87	5.44
Calf circumference (cm.)	36.03	3.25	7.48
Sitting height (cm.)	88.18	2.98	4.30
Supra-iliac skin fold (mm.)	11.99	6.19	48.20
Thigh skin fold (mm.)	8.69	2.98	35.47
Sub- scapular skin fold (mm.)	7.29	2.45	34.55
Calf skin fold (mm.)	8.35	3.25	37.29
Bicep skin fold (mm.)	2.57	0.88	33.96
Tricep skin fold (mm.)	4.25	1.30	32.78

SD = Standard Deviation, CV = Coefficient of Variance, Significant Value of Coefficient of Variable *Significant at 0.05

Table-3
Table showing Correlation matrix between playing ability and anthropometric variables

Variables	Correlation	Level of significant
Age	.297*	<.01
Height (cm.)	.684*	<.01
Weight (Kg.)	.135	>.01
Shoulder width (mm.)	.99	>.01
Biacromion width (mm.)	.385*	<.01
Arm length (cm.)	.597*	<.01
Upper arm length (cm.)	.499*	<.01
Fore arm length (cm.)	.127	>.01*
Leg length (cm.)	.470*	<.01*
Calf circumference (cm.)	.490	<.01*
Sitting height (cm.)	.588	<.01*
Supra- iliac skin fold (mm.)	.177	>.01
Thigh skin fold (mm.)	.471	>.01*
Sub-Scapular skin fold (mm.)	.260	<.01*
Calf skin fold (mm.)	.467	<.01*
Bicep skin fold (mm.)	.224	<.01*
Tricep skin fold (mm.)	.626	<.01*

*Significant at 0.05

The table showed that playing ability in handball was positively and significantly related to some of the anthropometric variables such as age (r =.297), height (r -.684) biacromion width (r = .385) arm length (r =.597) upper arm length (r= 499) leg length (r= 470), calf circumference (r=490), sitting height (r=588), thigh skin fold (r= 471) sub scapular skin fold (r= 260) calf skin fold (r=467), bicep skin fold (r= 282) tricep skin fold (r=626) at one per cent level of confidence. Super- iliac skin fold was significant (r=199) at five present of confidence while weight (r= .128) shoulder width (r= .93) forearm length (r= .117) were not significantly.

It is, therefore evident from the analysis of table related 4.2 that age, height, biacromion width, arm length, upper are length, leg length, calf circumference, sitting height and super iliac skin fold, thigh skin folds, sub scapular skin fold, calf skin fold, bicep and tricep skin fold had significant relationships with the performance in handball and can be said with confidence that these variable are important as for as performance in handball is concerned. These variables should be taken care of while selecting players as the time of induction of beginners of the game or at the time of selection of the teams.

Table-3 further above showed that weight, shoulder width and fore arm length did not contribute to handball playing ability.
Logically, there were two types of combinations of anthropometric parameters. First of all, all the 17 parameters were tried, but there was a problem of multicollinearity of height with sitting height and leg length as height is the sum total of sitting height and leg length. These three variables cancelled the effect of each other in the final equation in this trial. In order to overcome this problem, two different sets of parameters were tried. First set included sixteen variables including sitting height and leg length and excluding height. The final equation came out to be the same as was found in case of first trial when all the seventeen parameters were tried. Therefore another set of parameters including fifteen parameters was tried which included height and excluded setting height and leg length. Now height itself came to be a significant contributor toward playing ability and R^2 also improved/slightly. Therefore the final equation of the 2nd set was chosen for the study. The results of the combined contribution of anthropometrical variables, through the applications of multiple regressions, have been presented in Table-4. It was observed that height had .036 regression coefficient and 18.98% contribution toward R^2 which was significant at <.05 level. Calf circumference had .100 regression coefficient and 16.24% contribution toward variance which was significant at < .01 level. Supra iliac skin fold had .48 regression coefficient and 7.20 % contribution towards variance which was significant at <.01 level and thigh skin fold had-.096 regression coefficient and 20.70% contribution towards variance which was significant at <.01 level. Bicep skin fold showed -.313 regression coefficient and 11.96% contribution towards variance which was significant at <.01 level. The last anthropometric variable for the prediction of hand playing ability was tricep skin fold , which had .218 regression coefficient and maximum contribution towards variance was 26.24% which was significant at <.01 level. The combined contribution of all the anthropometric variables in the preliminary multiple regression was found 72.34 percent of variation in the playing ability of handball players while variables included in the final run equation, namely height, calf circumference, supra iliac skin fold, thigh skin fold bicep skin fold and tricep skin fold explained as high as 69.55 percent of variation in the playing ability of handball players. This showed that nine variables other than mentioned above secured a negligible share to the tune of only 2.89 percent of the variation. This revealed that five variables included in the final run equation were very powerful in predicting the playing ability of handball players. The regression coefficient of the height was positively significant which indicated an increase of .036 score in playing ability with an increase of one centimeter in height. The regression coefficient of calf circumference (.100) came to be positively significant which indicated that an increase of one centimeter in the existing average calf circumference of the players in the sample of the study i.e. 34.01 cm would lead to an increase of .100 score in the playing ability of the players. The regression coefficient of supra- iliac skin fold (.48) highlighted that the performance of the handball players and would be better by .046 score if an increase of one mm. in the supra- iliac skin fold would occur. This showed that existing supra-iliac skin fold still has increasing returns towards playing ability. The trends in the case of thigh, biceps skin fold and triceps skin fold were found to be inverse. An increase of one mm. each in these parameters would contribution respective decline of .096, .313, and .220 score towards playing ability of the handball players of the Inter University handball female. Therefore, the indication

of the analysis is that all the skin fold except supra iliac skin fold needs to be controlled while height, calf circumference and supra- iliac skin fold still have their role to play towards growth of playing ability of handball players

The equation is as under: $Y= - 4.24+.38x_2+.100x_{10}+.48x_{12}-.96x_{13}-313x_{16}-220x_{17}$, X_2 = Height, X_{10}= Calf Circumference, X_{12}= Super iliac skin fold, X_{13}= Thigh skin fold, X_{16}= Bicep skin fold, X_{17}= Triceps skin fold

The mean values, standard deviations and coefficients of variation of motor fitness variables have been presented in table-5. It was observed that 50 meter sprint had 8.59 mean,4 .48 standards deviation and 6.24 coefficient of variation , 30 meter sprint had mean 5.95 standard deviation 0.45 and coefficient of variation 8.88, shuttle run had mean 11.40 standard deviation 0 .86 and coefficient of variation 2.88 and 11.85 coefficient of variation. Handball throw had mean 37.67 standard deviation 4.87 and coefficient of variation 13.04, pull ups had mean 7.36 standard deviation 2.26 and coefficient of variation 36.24,standing broad jump had 3.37 mean standard deviation 0.24 and 9.53 coefficient of variation. Sergent jump had mean 47.89 standard deviation 4.94 and coefficient of variation 11.52. Twelve minute run walk had mean 2509.67 standard deviation 215.77 and coefficient of variation 10.28. Grip strength (Dominant hand) had mean 76.86 standard deviation 7.89 and coefficient of variation 12.58.Grip strength (non dominant hand) had mean 76.86, standard deviation 7.84 and coefficient of variation 12.58.

Table-4
Table showing Effect of anthropometric parameters on playing ability

Variables	Regression Coefficient	R Value	Contribution Towards R	Level of Significance	% Contribution Towards R
Height	.38	.6955	13.13	<.05	18.98
Calf Circumference	.100		11.23	<.01	16.24
Supra iliac SF	.48		4.89	<.01	7.28
Thigh Skin fold	.96		14.41	<.01	20.70
Bicep Skin fold	.313		7.78	<.01	11.16
Tricep Skin fold	.220		18.25	<.01	26.24

Intercept (a) - 4.24, R = .6955, F ratio = 38.00, Level of significance = < .01, Difference in R of first and final equation = 7234-.6955=.0289, The equation is as under, $Y= 4.24 + .038x_2 + .100x_{10}+.46\ x.48x_{12}\_.96x_{13}\_.313x_{16}\_.220x_{17}$, Where Y= playing ability

Table-5
Table showing Mean value of motor fitness tests

Motor fitness motor	Mean	S.D	C.V. (%)
50 meter sprint	8.59	0.48	6.24
30 meter sprint	5.95	0.45	8.88
Shuttle run	11.40	0.86	8.18
Zigzag run	25.28	2.88	11.85
Handball throw	37.67	4.87	13.04
Pull –ups	7.36	2.26	36.24
Standing Broad jump	3.37	0.24	9.53
Sargent jump	47.89	4.94	11.52
12 minute run/walk	2509.67	215.77	10.28
Grip strength (Dominant hand)	75.22	7.76	11.98
Grip strength (non dominant hand)	76.86	7.89	12.58

SD = Standard Deviation, CV = Coefficient of Variance

Table-6
Table showing Correlation matrix between handball playing ability and motor fitness test variables

Motor fitness tests	Playing ability (r)	Level of significance
50 meter sprint	.825	< .01
30 meter sprint	.818	<.01
Shuttle run zigzag run	.970	<.01
Zigzag run	.957	<.01
Handball throw	.998	<.01
Pull ups	.188	>.01
Standing Broad jump	.970	<.01
Sargent jump	.995	<.01
12 minute run/walk	.966	<.01
Grip strength (Dominant hand)	.197	N.S.
Grip strength (non dominant hand)	.327	<.01

*Significant at 0.05

Table-7
Table showing Effect of motor fitness test variables on playing ability

Variables	Regression Coefficient	R^2 Value	Contribution Towards R	Level of Significance	% Contribution Towards R
50 meter sprint	.119		4.15	<.05	4.25
Shuttle run	.333		31.96	<.01	32.22
Sargent jump	.053	.9900	24.30	<.01	23.23
12- minute Run / walk	.003		22.70	<.01	25.56
Handball throw	.001		14.35	<.01	14.76
Intercept (a)	1.79			N.S	

R^2 = .9700, F ratio = 460.85, Level of signification = .01, Difference in R^2 of first and final equation = 9716- 9700= 0016
The equation is as under: $Y = 1.79 - .119x_{18} - 333x_{20} + 0.53x_{25} + .033x_{26} + .001x_{22}$, Where Y= playing ability. The following regression equation were drawn: $Y = 1.79 - .119x_{18} - .333x_{20} + .53x_{25} + .33x_{26} + .001x_{22}$, Y= playing ability, X_{18} = 50 meter spring, X_{20}= Shuttle run, X_{25}= Sargent jump, X_{26} =12- minute Run / walk, X_{22}= Handball throw

Analysis of data given in table showed that playing ability in handball was significantly related to some of the motor fitness variables such as 50 meter sprint (r=-825), 30meter sprint (r=.818) Shuttle run (r=.970) zigzag run (r=.957) handball throw (r=.998) standing broad jump (r=.970), sergeant jump (r=.995). 12 minute run walk (r=.966) and non dominant hand grip strength (r=.327) at < .01 level of significance . Only two variables pull ups (r=.188) and dominant hand grip strength (r=.197) were not significant. It was observed that playing ability of handball players was positively influenced by distance covered by hand ball throw, standing broad jump, sargent jump, 12 minute run/walk and strength of non dominant hand whereas the fitness parameters like speed and agility were negative factors in relation to the playing ability i.e. less is the time taken for 50 meter, 30 meter, sprint shuttle run and zigzag run the better is the level of playing ability of handball players. It is therefore, evident that distance covered in handball throw, standing broad jump, Sargent jump, 12 minute run/walk, strength of non dominant hand, 50 meter sprint, 30 meter sprint, shuttle run and zigzag run were essential components for the performance in handball. Analysis in the table mentioned above showed that pull ups and dominant Hand grip strength did not contribute to handball playing ability.

Shuttle run had - .333 regression coefficient and maximum contribution 32.22 per cent towards R^2 which was significant at < .01 level sargent jump had .053 regression coefficient and 25.23 percent contribution was <.01, 12 minute run /walk had .003 regression coefficient and 25.56 percent contribution towards R^2 and the level of significance was <.01, handball throw had .001 regression coefficient and 14.76 percent contribution towards R and the level of significance was <..01 and 50 meter sprint had.119 regression coefficient and 4.30 percent contribution towards R^2 which was significant at <.05 level. The regression coefficient of 50 meter sprint (.119) highlighted that there would be an increase of .119 score with a decrease of one second in the time taken for 50 meter sprint while a decrease of one unit of time taken for shuttle run would cause an increase of .331 score in the playing ability. The regression coefficient of handball throw (.033) indicated that an increase of .001 score in playing ability would occur with an increase of one meter in the distance covered by throwing handball. Similarly, the increase of one inch in sargent jump would contribute .051 score towards playing ability while an increase of one unit in 12 minute run walk would improve the playing ability by. 003 score. The contribution of all the motor fitness variables in the preliminary multiple regression was found to be 93.16 percent of variation in the playing ability of handball players, while the variables included in the final run equation, namely time taken for 50 meter sprint, shuttle run, distance covered by handball throw sargent jump and 12 minute

run/walk explained as high as 96.00 percent of variation in the playing ability of handball players. This showed that six variables other than mentioned above secured a negligible share to the tune of only 0.16 percent of the variation. This revealed that five variables included in the final run equation were very powerful in predicting the playing ability of handball players.

Table-8
Table showing Mean value of motor skill tests

Motor skill tests	Mean	S.D	C.V.%
Dribbling	10.64	1.20	12.29
Passing	49.85	5.78	11.84
Handball Throw	37.67	4.79	13.04
Throwing ability (dominant hand)	25.29	2.97	12.17
Throwing ability (Non-dominated hand)	21.28	2.84	13.28
Throwing accuracy	34.69	7.73	22.27
Defensive movements	11.38	1.43	12.60

S.D= Standard Deviation, C.V.= Coefficient of Variance

It showed that dribbling had mean 10.64 standard deviation 1.20 and coefficient of variation 12.29, passing and mean 49.85, standard deviation 5.78 and coefficient of variation 11.84, handball throw had 37.17 mean, 4.79 standard deviation and 13.04 coefficient of variation. Throwing ability had mean 25.29 standard variation 2.97 and coefficient of variation 12.17. Throwing ability (dominant hand) had 21.28 mean 2.84 standard deviation 1.43 and coefficient of variation. Throwing accuracy had mean 34.69, standard deviation7.73 and coefficient of variation 22.27. Defence movement had mean 11.38, standard deviation 1.43 and coefficientofvariatio12.60. The coefficient of variation showed that there was not much variation amongst handball players in different motor skill variables excepts throwing accuracy. The variation ranged between 11.72 percent in passing to 12.88 percent in throwing ability of non dominant hand. The variables in throwing accuracy came to be as much as 22.52 percent.

Table-9
Table showing Correlation matrix between playing ability and motor skill variables

Motor skill variables	Playing ability	Level of significance
Dribbling	.367	<.01
Passing	.997	<.01
Handball Throw	.998	<.01
Throwing ability (dominant hand)	.950	<0.1
Throwing ability (Non Dominant hand)	.313	<0.1
Throwing accuracy	.867	<0.1
Defensive movement	.892	<0.1

It is obtained from the Table that all the seven motor skill variables bore significant relationship at 0.01 level, with playing ability of handball players. Dribbling had (r=.367) Defensive movement (r=.892) were adversely influencing the playing ability while passing had (r=.997), handball throw (r=.996) throwing ability of dominant hand (r=.950) as well as non-dominant hand (r=.313) and throwing accuracy (r=.867) exerted positive impact on playing ability. The analysis also highlighted that score of passing handball throw, throwing ability of dominant as well as non- dominant hand and service accuracy were positively correlated with playing ability whereas dribbling and defensive movements were inversely correlated with playing ability of handball players.

Contribution of motor skill variables on playing ability: Multiple regression equation in linear model was applied to evaluate the contribution of various motor skill variables towards overall playing ability of handball players. Five out of seven variables emerged as highly significant determinants of playing ability. Therefore only three equation were required to be tried for (Table-10). It was observed that passing had .056 regression coefficient and 25.33 percent variance which were significant at <.01, handball throw had .050 regression coefficient and 25.77 percent variance which were significant at 0.01 level of significance. Dominant Hand throwing ability had .054 regression coefficient and 15.63 percent variance, which was significant at .01 level. Throwing accuracy has .016 regression coefficient and 12.28 percent variance which was positively significant at .05 level, defensive movement had -.169 regression coefficient and 24.12 percent variance which was also significant at .01 level. The regression coefficient of passing (.042) showed that an increase of one score in passing would lead to an increase of .042 scores of playing ability. Similarly an increase of one meter in the distance covered by handball throw was bound to make an increase of .050 score in playing ability. The regression coefficient of throwing ability of dominant hand, (.054) highlighted that with an increase of one score of throwing ability of dominant hand there would be an increase of .054 scores of playing ability. The contribution of throwing accuracy was .016 score towards playing ability of handball players. The regression coefficient of defensive movements showed that a decrease of one second in defensive movements would lead to an increase of .169 score of playing ability. All the variables were significant at <.01 level of probability except throwing accuracy which was significant at <.5 level. The total contribution of all the motor skill variables in the preliminary multiple regressions was found 93.01 percent of variation in the playing ability of handball players while equation including five variables namely, passing, handball throw, dominant hand throwing ability, throwing accuracy and defensive movement explained as high as 92.93 percent of variance in the playing ability of handball players. This showed that two variables other than explained above secured a negligible share to the tune of only. 80 percent of the variation. This revealed that five variables included in the final equation were very powerful in predicting the playing ability of handball players.

Table-10
Table showing Effect of motor skill variables on handball playing ability

Variables	Regression Coefficient	R Value	Contribution Towards R	Level of Significance At	% Contribution Towards R
Passing	0.56		23.69	<.01	25.33
Handball Throw	0.60		22.88	<.01	25.77
Dominant Hand Throw ability	0.58	.9297	14.55	<.01	15.65
Throwing accuracy	0.18		13.43	<.05	12.18
Defensive movement	1.89		22.43	<.01	24.26

intercept (a) -.31, R = .9297, F ratio = 256.22, Level of significance = <.01, Difference in R of first and final equation = .9305-.9297 = .0008, The equation is as under : $Y = -.31 + .056\ x_{30} + .080x_{31} + .058x_{32} + .18x_{34} - .189x_{35}$, Where Y= playing ability
The following regression equation has been drawn: $Y = -.31 + .056 + .060x_{31} + .058x_{32} + .018x_{34} - .189x_{35}$, Y= playing ability, X_{30}= Passing, X_{31} = Handball Throw, X_{32}= Dominant hand throwing ability, X_{34}= Throwing accuracy, X_{35}= defensive movement

Table-10
Table showing Effect of motor fitness variables on handball playing ability

Variables	Regression Coefficient	R^2 Value	Contribution Towards R^2	Level of Significance	% Contribution Towards R^2
30 meter sprint	-.124		4.37	<.05	4.53
Shuttle run	-.387		27.56	<.01	29.57
Sergeant jump	.051		21.48	<.01	21.23
12 minute Run/walk	.001	.9636	19.99	<.01	23.83
Hand ball throw	.040		13.06	<.01	11.54
Defensive movement	.085		9.98	<.01	13.37
Intercept (a)	2.59			<.05	

Difference in R^2 of first and final equation = .9665 -.9637 = .0029. The equation is under: $Y = 2.59 - .124x_{19} - .387x_{20} + .051x_{25} + .001x_{26} + .040x_{22} - .085x_{35}$, Where Y= playing ability

Combined Contribution of Anthropometric, Motor Fitness and Motor Skill Variables to Handball Playing Ability: It can be concluded that fitness and skill variables are highly dependent on each other, while anthropometric variables have nothing to interact with fitness and skill performance, because while in the combined effect of anthropometric, motor fitness and motor skill variables on playing ability, no anthropometric parameter could turn to be significant. 30 meter sprint had.124 regression coefficient and 4.53 percent contribution towards R^2 which was significant. sprint had.124 regression coefficient and at <.05 level, shuttle run had.387 regression coefficient and 29.57 per sent Contribution which was significant at <.01 level, sergeant jump had .051 regression coefficient and 21.23 per cent contribution which was significant at <.01 level,12 minute run walk had .001 regression had .001 regression coefficient and 21.83 percent contribution which was significant at <.01 level handball throw had .030 regression coefficient and 11.54 per cent contribution and <.01 level of significance and defensive movements had -.85 regression coefficient and 13.37 per cent contribution which is significant at <.01 level. The regression coefficient of 30 meter sprint (-.124) highlighted that there would be an increase of .124 score with a decrease of one second in the time taken for 30 meter sprint while a decrease of one second of time taken for shuttle run would cause an increase of .285 score in the playing ability with the increase of one inch in sergeant jump would increase by .041 score. The regression coefficient of 12 minute run/walk indicated that an increase of one meter in run/walk would lead to an increase of .001 score of playing ability. Similarly, the increase of one meter in the distance covered by handball throws would contributed .030 score towards playing ability. The regression coefficient of defensive movements highlighted that there would be an increase of .083 score with a decrease of one second in the time taken for defensive movements. The variables included the final run equation namely 30 meter sprint ,shuttle run, sergeant jump ,12 minute walk handball throw and defensive movement explained 96.34 per cent of the variation in the playing ability of handball players. This revealed that above mentioned variables were very powerful in predicting the playing ability of handball players. The following final run regression equation was drawn:

$$Y = 2.57 - .112x_{19} - .285x_{20} + 0.41x_{26} + .001x_{25} + .030x_{22} - .083x_{35}$$

Where Y=Playing ability, X_{19}= 30 meter sprint, X_{20}= shuttle run, X_{25}= Sergeant jump, X_{26}= 12 minute run walk, X_{22}= Handball throw, X_{35}= Defensive movement

Conclusion

i. The anthropometric variables namely age, height biacromion width arm length, upper arm length, leg length, calf circumference , sitting height, supra-iliac skin fold were found to be positively significant in relation to the performance of handball players. ii. The motor fitness variables namely speed,

agility, power of arm, power of legs, endurance and left handgrip strength were found to be significantly related to the performance of handball players. iii. Dribbling, passing handball throw, dominant hand throwing ability, non dominant hand throwing ability, throwing accuracy and defensive movement motor skill variables were found to be significantly related to the performance of handball players.

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