



ISSN: 2456-0057
IJPNPE 2019; 4(1): 2277-2281
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www.journalofsports.com
Received: 05-01-2019
Accepted: 18-02-2019

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Study on maximal oxygen consumption in different team games

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Abstract

Introduction: $VO_2\max$ is used to monitor the training status and is considered as the most important determinant to predict the aerobic fitness of players. The $VO_2\max$ gives endurance value among the football, hockey, basketball and handball players. Still there is the need to justify the required $VO_2\max$ of team games of a certain level.

Objective: To compare the $VO_2\max$ profiles among the different selected team games and develop a single norm of all the games for the prediction of $VO_2\max$ efficiency.

Methods: Total 120 players (18 to 25 years of age), 30 each from football, hockey, basketball and handball games represented in the national championships were selected. Cooper's 12 min. run-walk test was administered to obtain the data for $VO_2\max$. Descriptive, t-test and ANOVA were employed, and tested at 0.05 level of confidence. The norm and grading were developed by using the Hull and 6-sigma scales respectively.

Result: Significant differences of $VO_2\max$ were found for both football and hockey players along with basketball and handball players, whereas insignificant differences were found in between football & hockey players, and basketball & handball players. Significant differences among the group means were found and followed by post-hoc test to find out the paired means differences. The single norm and grading scale were also developed.

Conclusion: Insignificant differences of $VO_2\max$ were found in between the football & hockey players, and basketball & handball players; whereas significant differences were found between football & basketball, football & handball, hockey & basketball, and hockey & handball players. A single norm was developed to predict the standard efficiency of $VO_2\max$ for the selected team games.

Keywords: football, hockey, basketball, handball, Cooper's 12 min run-walk, and $VO_2\max$.

Introduction

Every human being has a fundamental right to access to physical activities and sports, which are essential for the wholesome development of his personality. The freedom to develop physical, intellectual and moral powers through physical education and sports must be guaranteed both within the educational system and in other aspects of social life. The physiological adaptation to training is specific to the muscle activity, dominant energy system involved, muscle groups trained, as well as intensity and volume of training (Żebrowska, *et al.*, 2012) [1]. Sports such as football, hockey, basketball and handball games require the high repetitive intensive activities with brief intermittent recovery periods that sustaining for long duration. In football, hockey, basketball and handball, technical and tactical skills as well as the physical performance capacity of the players are most important factors that contribute to the success of a team in competitions. Competitive football, hockey, basketball and handball are demanding sports that require speed, agility, strength, muscular power and aerobic fitness. Players require the ability to perform repeated maximal or sub-maximal intensive activities such as jumping, sprinting, changing of direction etc. throughout the match. Therefore, high oxidative energy level is required throughout the match. The demand of oxygen differs from one sport to other sports (Singh and Patel, 2014) [5]. Thus, the energy requirement is met by anaerobic metabolism during high intensity exercise periods while aerobic metabolism gains importance in order to supply homeostatic conditions at recovery intervals. The Maximal oxygen uptake ($VO_2\max$) is a key indicator to assess health as well as sports performance (Matabuena, *et al.* 2018) [11]. Improvements in aerobic capacity are not only important for

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endurance performance, but also intermittent activities. Measurement of $VO_2\max$ has commonly been used to monitor the training status of athletes and can help to determine the training regime and schedules. Dolittle and Bigbee (1968) [18] stated that the distance covered during the 12-min. run-walk was a highly reliable and valid indicator of cardio-respiratory fitness and that it was to be preferred to the 600-yd. run-walk in this regard. However, Surwase, et.al. (2015) [16], suggested that the $VO_2\max$ could be calculated by Harvard step test and anaerobic power by Vertical Jump reach test. The $VO_2\max$ gives values of players that indicate important contribution of physiological requirements.

Base on the importance of physiological work capacity, the purpose of this study was to determine the difference in $VO_2\max$ values among the football, hockey, basketball and handball players. $VO_2\max$ is one of the most important parameters used to determine the aerobic fitness of players.

2. Objective of the Study

The main objective of the study was to compare the $VO_2\max$ profiles among the different selected team games. Further, to develop a single norm of all the games for the prediction of standard efficiency of $VO_2\max$ was emphasized.

3. Hypotheses of the Study

Relevant to the nature of the study the following hypotheses have been stated:

H₁: There would be significant differences of $VO_2\max$ among the different team games.

H₂: Football players would have higher $VO_2\max$ than hockey, basketball and handball players would.

4. Methodology

One hundred and twenty (N=120) national players, thirty (30) each from football, hockey, basketball and handball games were purposively selected from YAS, SAI and different clubs of Manipur, those were representing in the National championships within the last two years and regularly attending the respective continuous training program. The age of the subjects ranged between 18 to 25 years. The pertaining data was collected by administering the Cooper's 12 min run-walk test and $VO_2\max$ was determined in ml/kg/min. To develop the $VO_2\max$ profiles of the players, descriptive analysis were employed. To find out the significant differences between the means of the groups, independent t-test and ANOVA were employed, and tested at 0.05 level of confidence. In addition, to develop the norms of $VO_2\max$, Hull scale technique was used.

5. Results

The pertaining data of $VO_2\max$ were treated by using the descriptive analysis to find out the means (M), standard deviations (SD) and standard errors (SE) shown in table 1. Independent 't' test was employed to find out the significant differences of means of $VO_2\max$ in pair among the football, hockey, basketball and handball players as shown in table 2.

Table 1: Descriptive Analysis of $VO_2\max$ for different Team Games

Group	Range	Min.	Max	Mean	SE	SD	Var.
Football	8.05	54.65	62.70	59.02	0.44	2.40	5.74
Hockey	8.94	53.53	62.47	58.03	0.43	2.37	5.62
Basketball	18.10	43.47	61.57	51.13	0.67	3.66	13.36
Handball	15.20	46.83	62.03	52.74	0.67	3.64	13.27

Table 1 presents the descriptive means profile measures of 12 minutes run-walk test ($VO_2\max$) for football, hockey, basketball and handball players aged between 18 to 25 years are 59.02 ± 2.40 , 58.03 ± 2.37 , 51.13 ± 3.66 and 52.74 ± 3.64 respectively. Further, it shows that the football players achieved the highest mean scores and lowest mean score favour to basketball players. The profile range of $VO_2\max$ for the selected national standard players of football, hockey, basketball and handball statistically estimated within 52.74 to 59.02 (ml/kg/min) and might be advocated to develop a common standard norm.

Table 2: Comparison of $VO_2\max$ between Different Team Games

Groups	N	Mean	Std. Dev.	SE _M	Df	t- value
Football	30	59.02	2.40	0.44	58	1.61
Hockey	30	58.03	2.37	0.43		
Football	30	59.02	2.40	0.44	58	9.90*
Basketball	30	51.13	3.66	0.67		
Football	30	59.02	2.40	0.44	58	7.89*
Handball	30	52.74	3.64	0.67		
Hockey	30	58.03	2.37	0.43	58	8.68*
Basketball	30	51.12	3.66	0.67		
Hockey	30	58.03	2.37	0.43	58	6.67*
Handball	30	52.74	3.64	0.67		
Basketball	30	51.13	3.66	0.67	58	1.72
Handball	30	52.74	3.64	0.67		

*Significant at 0.05 level of confidence;

Tabulated $t_{0.05}(58) = 2.0017(N=60)$

Table 2 revealed that the t-values for the mean of two groups between different team games i.e. football & hockey, football & basketball, football & handball, hockey & basketball, hockey & handball, and basketball & handball were 1.61, 9.90, 7.89, 8.68, 6.67 and 1.72. It indicates that there were insignificant differences in $VO_2\max$ between football & hockey and basketball & handball players as the calculated values of 't' (1.61 and 1.72 respectively) are lesser than the table value of 't' (2.00). Again, it indicates that there were significant differences in $VO_2\max$ between football & basketball, football & handball, hockey & basketball, and hockey & handball as the calculated values of 't' (9.90, 7.89, 8.68 and 6.67) are greater than the table value of 't' (2.00). Further, to find out the significant differences among the means of $VO_2\max$ of football, hockey, basketball and handball, one way ANOVA was employed and shown in the table 3.

Table 3: Significant Differences among the Means of $VO_2\max$ of Different Team Games

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1358.16	3	452.72	47.66*	0.00
Within Groups	1101.82	116	9.50		
Total	2459.98	119			

*Significant at 0.05 level of confidence;

Tabulated $F_{0.05}(3,116) = 2.68$

Table 3 reveals that there were the significant differences of $VO_2\max$ among the selected team games as the calculated value of 'F' = 47.66 is quite higher than the table of 'F' = 2.68 at 0.05 level of confidence. Since the F-ratio found to be interestingly significant, to determine the paired mean differences among the selected team games, the Scheffe post-hoc test was employed and shown in table 4.

Table 4: Paired Means Differences among the Four Different Team Game

Mean				Mean Diff.	Sig.	Critical Diff.
Football	Hockey	Basketball	Handball			
59.02	58.03			0.99*	0.67	0.796
59.02		51.13		7.89*	0.00	0.796
59.02			52.74	6.28*	0.00	0.796
	58.03	51.13		6.89*	0.00	0.796
	58.03		52.74	5.28*	0.00	0.796
		51.13	52.74	1.61*	0.25	0.796

*Significant at 0.05 level.

It is evident from the above table 4 that the paired means comparisons through post-hoc test, there were found significant differences in between football & hockey (MD=0.99>0.796), football & basketball (MD=7.89>0.796),

football & handball (MD=6.28>0.796), hockey & basketball (MD=6.89>0.796), hockey & handball (MD=5.28>0.796), and handball & basketball (MD=1.61>0.796). The mean differences are graphically represented in fig 1.

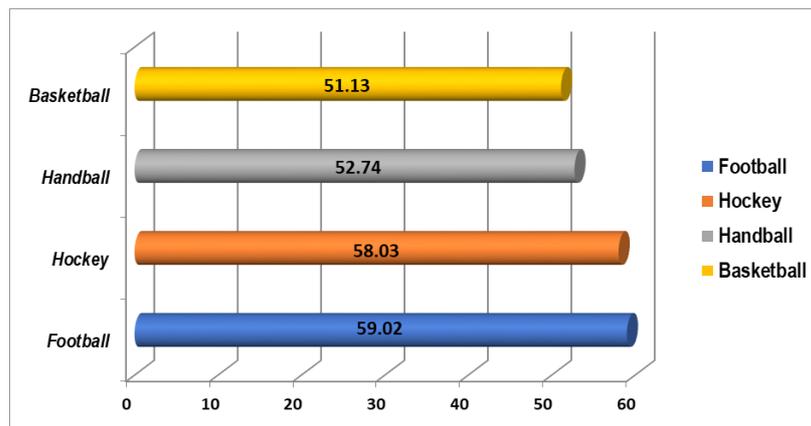


Fig 1: Means Differences of VO₂max among the Selected Team Games

6. Development of Norms

In this study, a single norm was developed for national level players of football, hockey, basketball and handball to identify the aerobic capacity between 18 to 25 years of age. For the development of norms, Hull Scale technique was employed. To developed the single norm of the selected four games, all the raw scores of each 120 players were added separately. The Descriptive analysis of the VO₂max of the 120 players is shown at table 5.

Table 5: Descriptive Analysis of VO₂max of the 120 Players

N	Range	Minimum	Maximum	Mean	SD	SE	Var.
120	19.23	43.47	62.70	55.23	4.55	0.42	20.67

Table 5 shows that the score of VO₂max was ranged between 43.47 to 62.70; the mean score, standard deviation (SD), standard error (SE) and variance of the score were 55.23, 4.55, 0.42 and 20.67.

By using the mean and standard deviation (SD) stated in the table 5, the single norm of VO₂max has been shown in table 6.

Table 6: Single Norm of VO₂max

Scale	Test Score
100	65
95	64
90	63
85	62
80	61
75	60
70	59
65	58
60	57
55	56
50	55
45	54
40	53
35	52
30	51
25	50
20	49
15	48
10	47
5	46
0	45

Finally, for the interpretation of VO_{2max} , the grading scale was developed by employing the 6- sigma scale, i.e. 3-Sigma above the mean and 3-Sigma below the mean. The 6-Sigma scale for VO_{2max} scores has been shown in table 7.

Table 7: 6-Sigma Scale of VO_{2max}

6-Sigma Scale	VO_{2max}
3σ	64
2σ	61
1σ	58
0	55
-1σ	52
-2σ	49
-3σ	46

Interpretation of VO_{2max}

Based on tables 6 and 7 the grading scale with interpretive names are given in table 8.

Table 8: Interpretation of VO_{2max}

Score	Alphabetical Grade	Interpretive Grade
Above 61	A ⁺	Excellent
58 to 61	A	Very Good
55 to 57	B	Good
52 to 54	C	Average
49 to 51	D	Poor
Below 49	E	Very poor

From the above tables 7 and 8, the scores, which are more than 2σ score (61) was given "A⁺" or "excellent". The scores, which are in between 2σ score (61) and 1σ score (58) was given grade "A" or "Very Good". The scores, which is in between mean score (55) and 1σ score (58) was given grade "B" or "Good". The scores, which is below mean score (55) to -1σ score (52) was given grade "C" or "Average". The scores that are below -1σ score (52) to 2σ score (49) was given grade "D" or "Poor". Lastly, the scores, which are below -2σ (49) was given "E" or "Very Poor." Among these games, players who scores grade 'B' or 'Good' and above may be recommended of high efficiency of VO_{2max} .

7. Discussion

Based on the objectives of the study, the suitable statistical techniques were framed and the analysis and interpretation of data were formulated. The descriptive measures of Cooper's 12 min run-walk test for VO_{2max} of 120 National players, 30 each of the selected team games viz football, hockey, basketball and handball players aged between 18 to 25 years, showed the characteristics of the data pertaining in terms of range, mean, standard deviation, standard errors etc. There were the insignificant differences between football & hockey, and basketball & handball as the obtained value of 't' = 1.61 & 1.72 respectively were lesser than the table value of 't' = 2.0017 at 0.05 level of confidence for two tailed. The result behind that there may be similar nature or characteristics between the games of football & hockey, and basketball & handball in terms of movements, physical qualities, skills, psycho-physiological work intensities, strategies, similar dimension of the playing area, similar duration of game, system of play, training methods etc. Therefore, these conditions show the ultimate equation of producing physiological work capacities in terms of VO_{2max} between the football & hockey, and basketball & handball players. Whereas there were the significant differences between football & basketball, football & handball, hockey &

basketball, and hockey & handball as the obtained value of 't' = 9.90, 7.89, 8.68 and 6.67, respectively, which were greater than the table value of 't' = 2.0017 at 0.05 level of confidence for two tailed. The result behind might be because of differences in nature of the games, dimension of the playing areas, duration the play, training and competition demands, physical and physiological demands etc.

By the result of the study, the hypotheses H_1 had been accepted in case of relationship for football and hockey with basketball and handball. Meanwhile, the hypotheses H_1 had been rejected in case of relationship between football & hockey, and basketball & handball, simultaneously the null hypothesis was accepted. Football players with the highest VO_{2max} mean score, the H_2 had been accepted.

Further, a single norm was developed based on the VO_{2max} scores of football, hockey, basketball and handball. The norm was interpreted in the form grading viz Excellent, Very Good, Good, Average, Poor and Very Poor. Those players secured at least Good grading and above in the norm scale may be recommended as high efficiency of VO_{2max} for the players of the selected games.

7. Conclusion

Significant differences of VO_{2max} were found between football & basketball, football & handball, hockey & basketball, and hockey & handball players. Insignificant differences of VO_{2max} between football & hockey and handball & basketball players were found. The significant difference of VO_{2max} among the games might be due to the differences in nature of the games, dimension of the playing areas, duration the play, training and competition demands, physical and physiological demands etc. The insignificant differences of VO_{2max} might be due to similar nature or characteristics between the games of football & hockey, and basketball & handball in terms of movements, physical qualities, skills, psycho-physiological work intensities, strategies, similar dimension of the playing area, similar duration of game, system of play, training methods etc. A single norm was developed and might be recommended to predict the standard efficiency of VO_{2max} for the selected team games.

8. Acknowledgement

An acknowledgement was drawn to all the special players, associations, organizations, scholars and experts, who helped for the administration of test, data collection and analyses for the completion of this research work.

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