Chapter II
Review of Related Literature

Review of the literature offers close look in to research work to researcher. Reviews suggested a method and a technique of dealing with a problematic situation, which may also suggest avenues of approach to the situation of similar difficulties, scholars facing similar situation can provide the investigator new idea and approaches it also assist the researcher in evaluating own research efforts by comparing them with related efforts done by other. Before completing a plan for a research undertaking, person needs to conduct a literature search in the area of the proposed investigation. Therefore the researcher has conducted thorough reviews of article, books and similar research to understand the study more.

The details review has been classified as follows:

1. Review related to Handball research.
2. Review related to Morphological Variables.
3. Reviews related to Fitness and Performance.
4. Review related to Skill, Tactics and Performance.
5. Review related to Test Battery and Norms.

2.1. Review related to Handball research.

Tokumnosuke. (1988) clarified the effects of the alteration of the rules on the exercise intensities, skills and tactics in the handball game. Heart was recorded continuously throughout the game and VO2 max was determined by means of the step wised aerometry. Distance that players ran and dribbled was pursued and recorded by the investigator. In the newly modified local rules, players must be throwing off from the goalkeeper line. Therefore, the time for the next commencement of the game was shortened. Owing to this change of the rule, it was found that the total distances that the players ran and dribbled the number of shoots and the possibility of the fast break offense were increased. The average HR of the new local rule exceeded that of the international rule through the whole game. Though the HR of the new local rule remained unchanged through the whole game, the heart of the first period was

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reduced by about ten beats / min in 2 period in the case of the international rule. We estimated the exercise intensities of the players at the 90-98% VO2 max in the new local rule and the 75-90 % VO2 max in the international rule. From these results, we concluded that the alteration of the rules in Japan was successful to facilitate the activations of the handball game, for example, the speed of the player; the offensive method and the number of shoot chance.

The purpose of this study Singh, J. & Raj Kumar. (2008) was to prepare the ‘norms profile’ of specific skills of handball players with a view to compare and evaluate further planning of handball game as its not being practiced in our country at present. So, an objective was set by the researchers to prepare the norms for each important specific skill of handball game at school, university and senior level of performance. Total of five hundred eighty six (N=586) players of handball were examined during School National championship (N=200), All India Inter University championship (N=195) and Senior National championship (N=191). The tests of specific skills of Handball, standardized by Singh (2007) were used for record the specific skills of handball players. The percentile values were distributed through SPSS. These prepared norms are presented in tabular form. The research evaluation highlights that there is an increase of specific skills with participation level of handball players. Speaking specifically, the ‘different levels’ include the level of school to university and then from university to senior level. The implicational interpretation will result in the form of an increased competitive ability of the players.

Lidor, R., and Falk, B. (2005) conducted a study titled, ‘Measurement of talent in team handball: the questionable use of motor and physical tests’. The purpose of this study was to identify motor, physical, and skill variables that could provide coaches with relevant information in the selection process of young team handball players. In this study total 405 players (12-13 years of age at the beginning of the testing period) were recommended by their coaches to undergo a battery of tests prior to selection to the Junior National Team. This number is the sum of all players participating in the different phases of the program. However, not all of them took part in each testing phase. The battery included physical measurements are height, weight, 4 x 10-m running test, medicine ball throw and standing long jump, 20-m sprint from a standing

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position and a 20-m sprint with a flying start, slalom dribbling test used for data collection. Comparisons between those players eventually selected to the Junior National Team 2-3 years later with those not selected demonstrated that only the skill test served as a good indicator. In all other measurements, a wide overlap could be seen between the results of the selected and non-selected players. It is suggested that future studies investigate the usefulness of tests reflecting more specific physical ability and cognitive characteristics.

Won, O.M.\(^4\) (1988) studied the relative contribution of physical fitness and skill domain according to different skill level of handball players. Thirty three physical fitness and handball skill measures chosen from physique (6 items), muscular strength (5 items), muscular endurance (3 items), muscular power (5 items), agility (3 items), balance (3 items), flexibility (3 items), cardio respiratory (2 items), and handball skills (4 items) domain were tested on national representative (N= 21), University (N= 34), high school (N= 30) handball players. In order to investigate the relative contribution, communalities of 9 physical fitness and handball skill domains were evaluated for each different skill level group. The result indicated that degree of contribution of total variance were increasing tendency from 44.17 % to 57.08 % as the handball skill level increased. It implies that higher skill level groups are more explainable from 33 measures chosen than the lower skill level groups. In mean contribution to total variance for each 9 physical fitness and handball skill domain; physique, flexibility, cardio-respiratory endurance and handball skill domain were relatively high (11.50 % to 14.45 %), agility, muscular strength and endurance domains were moderate (10.65 % to 11.50 %), muscular power and balance domain were relatively low (8.88 % to 9.70 %). But these tendencies not always same each different skill level group.

The purpose of this study Sporis, G., & Vuleta, D.\(^5\) (2005) was to describe the structural and functional characteristics of elite Croatian handball players and to evaluate whether the players in different positional roles have different physical and physiological profiles. According to the positional roles, players were categorized as goalkeepers (n = 13), wing players (n = 26), backcourt players (n = 28) and pivot players (n = 25). The goalkeepers were older (p < 0.01), and the pivot players were


more experienced (p < 0.01) than the backcourt players. The wings were the shortest players in the team. The pivots were tallest and heavier than the backcourt and wing players (p < 0.01), whereas the backcourt players were tallest then wings (p < 0.01). Goalkeepers had more body fat than the backcourt and wing players (p < 0.01). The backcourt players had a lower percentage of body fat. The backcourt players were the quickest players in the team when looking at values of maximal running speed on a treadmill. The Goalkeepers were the slowest players in the team (p < 0.01). The best average results concerning maximal heart rate were detected among the backcourt players. There were no statistically significant differences between the players positions when measuring blood lactate and maximal heart rate. A strong negative correlation was found between body fat and maximal running speed (r = -0.68, p < 0.01).

Koc, H., & Tekin, A.⁶ (2012) conducted a study titled, ‘The Effect of acute exercises on Blood hematological parameters in handball players’. This study was conducted in order to determine the influence of five-day handball competitions on hematological levels of male handball players. 12 elite male handball players with an average age of 22.16±1.85 years participated in this study on voluntary basis. Physical measurements including body height, body weight, body-mass index and body fat percentages and hematological levels of the handball players were analyzed before (BC) and after the competitions (AC). In order to determine hematological levels, blood samples with 5 ml EDTA (Ethylenediaminetetraacetic acid) were taken from the forearm ante-cubital area in line with hygiene rules before and after competitions, and erythrocyte, leucocytes and blood platelet parameters were analyzed in laboratory with using auto-analyzers. Measurement results were presented as average and standard deviation. Student T-test for dependant samples was used in order to make a comparison between BC and AC values. SPSS 13.0 Package software was used for data evaluation <0.05 value was considered to be significant. As a result of the study, the decrease in BC and AC values for body weight, body-mass index, body fat percentages, MCV, MCH, CH and LY and the increase in RBC and NE values were

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found significant. Conclusively, erythrocyte, leucocytes and blood platelet levels display different behaviours vis-a-vis acute competition-like exercises.

Ingebrigtsen., Jorgen., Rodabl., Stein., Jeffreys., & Ian. (2012) This study first aimed to examine strength, speed and jumping abilities in 29 male and 29 female junior elite handball players, and secondly to compare Under-18 and Under-16 players in the selected parameters. Players were chosen by the Norwegian Handball Federation (NHF) and all were tested in strength (squat and bench press), speed (10 m, 30 m and 6 x 30 m repeated sprint ability) and jumping abilities (CMJ and SJ). Anthropometric qualities were also measured. Independent t-tests were applied in order to reveal possible mean differences between the U-18 and U-16 players within each sex. No significant differences in anthropometry were observed between the U18 and U16 players within either sex. Furthermore, researchers did not observe any significant between group differences among the male players in any of the tested performance parameters. On average, however, the U16 male (n=14) players performed better in all the tests compared to the U18 (n=15) male players. Similarly, researchers did not find any significant differences in test performances between U18 female players and U16 female players. Still, a few trends (p<=0.1) were observed as female U18 (n=14) players, were found to sprint faster on both 10 and 30 m, and to jump higher in SJ versus female U16 (n=15) players. The empirical findings do not confirm the hypothesis of pubertal development and muscle growth leading to taller and heavier U18 players. Furthermore, we expected U18 players to perform better in all tests when compared to U16 players. Again, the data did not substantiate this, although female U18 players tended to perform better in sprint and SJ compared to the U16 players.

Povoas Susana, C.A., Seabra., Andre., F.T., & Antonio, N.C. (2012) this study aimed to analyze elite team handball physical and physiological demands during match play. Time-motion (N = 30) and heart rate (N = 60) analyses were performed throughout ten official matches. The defined locomotors categories were standing still, walking, jogging, fast running, sprinting, backwards movement, sideways movements and a few other categories specific to handball. The data revealed that handball is a physically demanding sport, with high levels of anaerobic energy expenditure and aerobic fitness requirements.

medium-intensity movement and sideways high-intensity movement and playing actions studied were jumps, shots, stops when preceded by high-intensity activities, changes of direction and one-on-one situations. During matches the mean distances covered were 4370 +/- 702.0 m. Around 80% of total time was spent standing still (43.0 +/- 9.27%) and walking (35.0 +/- 6.94%), and only 0.4 +/- 0.31% with sprinting. The most frequent high-intensity actions were stops, changes of direction and one-on-one situations. Effective mean HR was 157 +/- 18.0 bpm (82 +/- 9.3% of HR max) and total HR was 139 +/- 31.9 bpm (72 +/- 16.7% of HR max). HR, time spent in high-intensity activities, frequency of stops, changes of direction, one-on-one situations and most intense periods of the game were higher during the first half than during the second half (p <= 0.05). The opposite was observed for the number of time-outs and the time between each change of activity (p = 0.00). Handball is an intermittent exercise that primarily utilizes aerobic metabolism, interspersed by high-intensity actions that greatly tax anaerobic metabolism. Additionally, exercise intensity decreases from the first to the second half of the match, suggesting that neuromuscular fatigue may occur during the game. The training of elite handball players should comprise exercises targeting the ability to perform specific high-intensity actions throughout the game and to rapidly recover during the less intense periods.

The purpose of this study Ignjatovic., & Aleksandar.⁹ (2011) was to examine the effects of medicine ball training on the strength and power in young female handball athletes. Twenty-one young female handball players (age: 16.9 +/- 1.2 years) were randomly assigned to experimental and control groups. Experimental group (n = 11) participated in a 12-week medicine ball training program incorporated into the regular training session, while controls (n=10) participated only in the regular training. Performance in the medicine ball throws in standing and sitting positions, one-repetition-maximum (1RM) bench and shoulder press and power test at two different loads (30% and 50% of 1 RM) on bench and shoulder press were assessed at pre- and post-training testing. The athletes participating in the medicine ball training program made significantly greater gains in all medicine ball throw tests compared to the controls (p<0.01). Also, the experimental group made significantly greater gains in

bench and shoulder press power than control group (p<0.05). Both training groups (E) and (C) significantly (p<0.05) increased 1RM bench and shoulder strength, with no differences observed between the groups. Additionally, medicine ball throw tests showed stronger correlation with power tests, then with 1RM tests. These data suggest that 12-week medicine ball training, when incorporated into a regular training session, can provide greater sport-specific training improvements in the upper body for young female handball players.

Vaara., Jani P., Kyrolainen., Heikki., Niemi., Jaakko., & Keijo. (2011) conducted a study titled, ‘Associations of maximal strength and muscular endurance test scores with cardio respiratory fitness and body composition’. The purpose of the present study was to assess the relationships between maximal strength and muscular endurance test scores additionally to previously widely study measures of body composition and maximal aerobic capacity. 846 young men (25.5+/−5.0 yrs) participated in the study. Maximal strength was measured using isometric bench press, leg extension and grip strength. Muscular endurance tests consisted of push-ups, sit-ups and repeated squats. An indirect graded cycle ergometer test was used to estimate maximal aerobic capacity (VO2max). Body composition was determined with bioelectrical impedance. Moreover, waist circumference (WC) and height were measured and body mass index (BMI) calculated. Maximal bench press was positively correlated with push-ups (R2=0.37, p<0.001), grip strength (R2=0.12, p<0.001) and sit-ups (R2=0.12, p<0.001) while maximal leg extension force revealed only a weak positive correlation with repeated squats (R2=0.05, p<0.001,). However, moderate correlation between repeated squats and VO2max was found (R2=0.30, p<0.001) In addition, BM and body fat correlated negatively with muscular endurance (R2=0.10-0.22, p<0.001), while FFM and maximal isometric strength correlated positively (R2=0.13-0.20, p<0.001). In conclusion, muscular endurance test scores were related to maximal aerobic capacity and body fat content, while fat free mass was associated with maximal strength test scores and thus is a major determinant for maximal strength. A contributive role of maximal strength to muscular endurance tests could be indentified for the upper, but not the lower extremities. These findings

suggest that push-up test is not only indicative of body fat content and maximal aerobic capacity but also maximal strength of upper body, whereas repeated squat test is mainly indicative of body fat content and maximal aerobic capacity, but not maximal strength of lower extremities.

Vila, H., Manchado, C., Rodriguez, N., Abraldes, V. P., Alcaraz., & Fferraqut, C. F. 11 (2011) conducted a study titled, ‘Anthropometric profile, vertical jump and throwing velocity, in female elite handball players by playing positions’. The aim of this study was to describe anthropometric characteristics, throwing velocity, hand grip and muscular power of the lower limbs in female handball players and to identify possible differences in these parameters in terms of individual playing positions (center, back, wing, pivot and goalkeeper). A total of 130 Spanish female elite handball players participated in the study (25.74 +/- 4.84 years; 14.92 +/- 4.88 years of playing experience). Anthropometric assessment was performed by all subjects following the International Society for the Advancement of Kinanthropometry (ISAK) protocols. Furthermore, all subjects performed a vertical jump test (Squat Jump and Countermovement Jump). Hand grip and throwing velocity in several situations were also assessed. A one-way analysis of variance ANOVA and a Tukey post hoc test were used to study differences among individual playing positions. Wings were less heavy, shorter and showed less arm span, than goalkeepers, backs and pivots. (p<=0.001). Additionally pivots were heavier than centers. Backs and pivots exhibited higher muscular mass than wings. Total player's somatotype was mesomorphy-endomorphy (3.89 - 4.28 - 2.29).Centers showed higher throwing velocity levels than wings in 9 m throws from just behind the line, with a goalkeeper. Backs exhibited higher hand grip values than wings. Statistical differences have been established between wings and others specific playing positions, especially with pivot and backs. Coaches can use this information in order to select players for the different specific positions.

Posters 12 (2011) conducted a study titled, ‘Injuries in Icelandic male team handball


players. The objective of study was to examine and document the incidence, nature and severity of injuries in male team handball. Players from all (eight) premiership and six best (of eight) second division teams were invited to participate. The selection was based on the 2006–2007 league position. 159 players from seven premiership and 4 division teams entered the study. 109 players from four premiership and 2 division teams finished it from all 86 injuries was recorded, 53 (61.6%) acute and 33 (38.4%) overuse injuries. The injury incidence was 15.0 injuries per 1000 player hours during games and 2.2 injuries per 1000 player hours during training. Acute injuries were most common in knees (26.4%). Overuse injuries were 33.3% most frequent in low back/sacrum/pelvic region. No difference was in incidence of injuries between teams. Back court players were most frequent injured, goalkeepers least. 22.4% of the players used ankle braces during games and most training sessions. 28.2% used tape on fingers. The total injury incidence is similar than in previous, comparable studies. However, higher rate of overuse injuries in low back/sacrum/pelvic region raise questions about training methods and preparation for the Icelandic team handball players.

Zech, A., & Steib, S. (2012) conducted a study titled, ‘Effects of localized and general fatigue on static and dynamic postural control in male team handball athletes’. The objective of this study was to determine the effects of whole-body and localized fatigue on postural control in stable and unstable conditions. Nineteen male team handball players were assessed in 2 sessions separated by 1 week. Treadmill running and single-leg step-up exercises were used to induce physical fatigue. The main outcome measures were center of pressure (COP) sway velocity during a single-leg stance on a force plate and maximum reach distances of the star excursion balance test (SEBT). The COP sway velocity increased significantly (p < 0.05) after general (+47%) and localized fatigue (+10%). No fatigue effects were found for the SEBT. There were no significant correlations between COP sway velocity and SEBT mean reach in any condition. The results showed that although fatigue affects static postural control, sensorimotor mechanisms responsible for regaining dynamic balance in healthy athletes seem to remain predominantly intact. Thus, data indicate that the exclusive use of static postural sway measures might not be sufficient to allow

conclusive statements regarding sensorimotor control in the non injured athlete population.

Lenzen., & Benoit. (2009) conducted a study titled, ‘Analysis of Team Handball Players Decisions: An Exploratory Study’. This exploratory study aimed to investigate elements involved in decision making in team handball live situations and to provide coaches and educators with teaching recommendations. The study was positioned within the framework of the situated-action paradigm of which two aspects were of particular interest for this project, the relationship between planning and action and the perception-action coordination. Qualitative methods used, which linked video observation of six female elite player’s actions during two championship matches and self-confrontation interviews. Player’s verbalizations reflected that their decision making included the following: (a) perception (visual, auditory, tactile, and proprioceptive), (b) knowledge (concepts, teammates and opponents characteristics, experience) (c) expectations (opponents and teammates intentions) (d) contextual elements (score, power play, players on the field, match difficulty). Findings were discussed in terms of teaching implications.

Vuleta., & Dinko. (2003) determines the relationship between variables of shooting for a goal and the final outcome of handball match. The data were collected from 38 games of the 2000 Men's European Championship, played in Zagreb and Rijeka. Twelve indicators of scoring efficiency, registrated for each national team, constituted the sample of manifest variables, whereas the criterion variable was a binary outcome of match-victory or defeat. The basic statistical procedures and regression analysis were used. Almost half of all the shots performed (44.61%) were executed from the back-court players' positions (field shots). The winning teams were considerably more efficient in fields shot and in 7m throws than the defeated ones-(43.20%) and (76.53%) as compared to (32.52%) and (65.76), respectively. The statistically significant multiple correlation of.71 means that the predictor variables share 50% of common variance with the final results of the observed matches. The winning teams had more successful field shots, 6m-centre shots and wing shots and fewer

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unsuccessful 6m-centre and field shots and 7m throws. Scoring efficiency from a
distance and from the 6m line differentiates the successful teams (winners) from the
unsuccessful (defeated) ones.

The purpose of this study **Chelly M.S., & Hermassi, S.** (2011) was to examine the
activity profile of elite adolescent players during regular team handball games and to
compare the physical and motor performance of players between the first and second
halves of a match. Activity patterns (video analysis) and heart-rate (HR) responses
(telemetry) were monitored in top national-division adolescent players (18 men, aged
15.1 ± 0.6 years) throughout 6 regulation games (25-minute halves with a 10-minute
interval). The total distance covered averaged 1,777 ± 264 m per game (7.4% less in
the second than in the first half, p > 0.05). Players ran 170 ± 24 m at high intensity
and 86 ± 12 m at maximal speed, with 32 ± 6 bouts of running (duration 2.3 ± 0.3
seconds) at speeds > 18 kmh(-1); they stood still for 16% of the playing time. The
mean HR during play was 172 ± 2 bmin (-1) (82 ± 3% of maximal HR). Blood lactate
concentrations at the end of the first and second halves were 9.7 ± 1.1 and 8.3 ± 0.9
mmol·L (-1), respectively (difference p < 0.05). The study conclude that adolescent
handball players cover less distance and engage in fewer technical actions in the
second half of a match. This indicates that team handball is physiologically very
demanding. The practical implication is that coaches should seek to sustain
performance in the second period of a game by modifying playing tactics and
maximizing both aerobic and anaerobic fitness during training sessions.

**Lopez, C.M., & Platen.** (2012) conducted a study titled, ‘Motion analysis in handball’. The
presentation gives a short overview on the available computer- and video-
analysis systems in team sports in the fields of biomechanics, for the determination of
the muscular status of a player, for the planning of training and analysis of
competition, for the technical and tactical analysis of a match, as well as for the
determination of the physiological demands like run distances, velocities, and sports
specific movements. Researchers give some examples of the combined analysis of
heart rates and run distances and velocities in female top level handball teams also
summarize the needs and information that should be available for a trainer in order to
optimize and individualize training and performance during competition.

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Fabrica., & Gabriel, C.\textsuperscript{18} (2008) Determines speed and angle of ball throwing in handball penalty were measured and the effects of the muscular fatigue and the differential tasks implied in the different field positions on these variables were studied. The ball thrown by ten players of the female Uruguayan national handball team were 2-D kinematically analysed in the lateral plane. Ball speed and output angle were analysed taking into account the match time and the player's position, either back or wing, using paired sample t-test (p<0.05). A significantly higher speed (p=0.0006) during the first half of match time, compared to the second, was found. Significant difference in the speed according to the position in the field was also warranted (p=0.00015), with backs throwing faster than wings. The throwing angle showed no differences for match time and position (p=0.43 and p=0.63, respectively). The variation in speed during the match could be due to the effect of the increase in muscular fatigue. The difference found for this variable according to the field position is congruent with the function players carried out during the match. The small variations in the shot angles are interpreted as indicative of technique predominance not affected by muscular fatigue.

Cherif, M., & Said, M.\textsuperscript{19} (2012) conducted a study titled, ‘The Effect of a Combined High-Intensity Polymeric and Speed Training Program on the Running and Jumping Ability of Male Handball Players’. The aim of this study was to investigate the effect of a combined program including sprint repetitions and drop jump training in the same session on male handball players. Twenty-two male handball players aged more than 20 years were assigned into 2 groups: experimental group (n=11) and control group (n=11). The selection of players was based on variables “axis” and “lines”, goalkeepers were not included. The experimental group was subjected to 2 testing periods (test and retest) separated by 12 weeks of an additional combined Plyometric and running speed training program. The control group performed the usual handball training. The testing period comprised, at the first day, a medical checking, anthropometric measurements and an incremental exercise test called yo-yo


intermittent recovery test. 2 days later, participants performed the Repeated Sprint Ability test (RSA), and performed the Jumping Performance using 3 different events: Squat jump (SJ), Countermovement jump without (CMJ) and with arms (CMJA), and Drop jump (DJ). At the end of the training period, participants performed again the repeated sprint ability test, and the jumping performance. The conventional combined program improved the explosive force ability of handball players in CMJ (P=0.01), CMJA (P=0.01) and DJR (P=0.03). The change was 2.78, 2.42 and 2.62% respectively. No significant changes were noted in performances of the experimental group at the squat jump test and the drop jump with the left leg test. The training intervention also improved the running speed ability of the experimental group (P=0.003). No statistical differences were observed between lines or axes. Additional combined training program between sprint repetition and vertical jump in the same training session positively influence the jumping ability and the sprint ability of handball players.

Granados, C., (2008) conducted a study titled, ‘Effects of an entire season on physical fitness in elite female handball players’. The study examines effects of an entire season on anthropometric characteristics, physical fitness and throwing velocity. Sixteen elite female handball players were selecting as sample of the study. One-repetition-maximum bench press (1RMBP), jumping explosive strength, power-load relationship of the leg and arm extensor muscles, 5-m and 15-m sprint running time, endurance running and handball throwing velocity were assessed in four periods. Individual volumes, intensities of training and competition were quantified for 11 activities. During the season, significant increases (P < 0.05-0.01) occurred in fat-free mass (1.8 1.2%), 1RMBP (11 7.4%), bench press (12-21%) and half-squat (7-13%) muscle power output, vertical jumping height (12 7.2%), throwing velocity (8 5.9%), and a significant decrease in percent body fat (9 8.7%). No changes were observed in sprint and endurance running. Significant correlations (P < 0.05-0.01) were observed between time devoted to games and changes in velocity at sub maximal loads during bench press actions, as well as between changes in muscle velocity output of the upper and lower extremities and changes in throwing velocity. Changes in percent body fat or body mass correlated (P < 0.01) positively with

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changes in maximal strength and muscle power. The handball season resulted in significant increases in anthropometric characteristics, physical fitness and throwing velocity. The correlations observed suggest the importance of including explosive strength exercises of the knee and elbow extensions. Special attention may be needed to be paid to the mode of body fat loss, to increase endurance capacity without interfering in strength gains. Official and training games may be an adequate stimulus for enhancing certain physical fitness characteristics in female elite handball players. Chaouachi, A.\textsuperscript{21} (2009) conducted a study titled, ‘Anthropometric, physiological and performance characteristics of elite team-handball players’. The objective of this study was to provide anthropometric, physiological, and performance characteristics of an elite international handball team. Twenty-one elite handball players were tested and categorized according to their playing positions (goalkeepers, backs, pivots, and wings). Testing consisted of anthropometric and physiological measures of height, body mass, percentage body fat and endurance (VO\textsubscript{2}max)), performance measures of speed (5m, 10m and 30m), strength (bench press and squat), unilateral and bilateral horizontal jumping ability and a 5-jump horizontal test. Significant differences were found between player positions for some anthropometric characteristics (height and percentage body fat) but not for the physiological or performance characteristics. Strong correlations were noted between single leg horizontal jumping distances with 5m, 10m and 30m sprint times ($r = 0.51-0.80$, $P < 0.01$). The best predictors of sprint times were single leg horizontal jumping with the dominant leg and the distance measured for the 5-jump test, which when combined accounted for 72\% of the common variance associated with sprint ability. In conclusion, performance abilities between positions in elite team-handball players appear to be very similar. Single leg horizontal jumping distance could be a specific standardized test for predicting sprinting ability in elite handball players.

Zapartidis, I., Toganidis, T., Vareltzis, I., Christodoulidis, T., Kororos, P., & Skoufas, D.\textsuperscript{22} (2009) conducted a study titled, ‘Profile of young female handball players by playing position’. The aim of the present study was to define and evaluate


the differences in physical fitness and anthropometric characteristics between the playing positions in young female team handball players. The sample consisted of 181 female young handball players with the mean age of 14.12±1.09 yrs, and 3.41±1.67 yrs of playing experience. Body height, body mass, body mass index, arm span, palm length and opening, standing long jump, 30m sprint, sit and reach flexibility and estimated vo2max were measured and throwing speed was assessed with a radar gun. Significant differences were detected among individual positions for height ($p<0.001$), body mass ($p<0.001$), BMI ($p<0.001$), arm span ($p<0.001$), palm opening ($p<0.001$), palm length ($p<0.001$), broad jump ($p<0.001$), ball throwing velocity ($p<0.001$), 30-m sprint ($p<0.001$) and estimated vo2max ($p<0.001$). Back players were the tallest, with the largest arm span, palm opening and palm length. Wing players were the shortest, with the least weight, the lowest BMI and the smallest palm opening and palm length among all players. Wings showed better performance than all other players in broad jump, 30-m sprint and vo2max. Back players achieved the highest values among all players in ball throwing speed, while goalkeepers' were the lowest. Goalkeepers underperformed in relation to all motor abilities compared to all other playing positions.

Hasan, A.A.A., & Rahaman, J.A. (2007) Conducted a study titled, ‘Anthropometric profile of elite male handball players in Asia’. The present study was conducted to describe the anthropometric characteristics of international male Asian handball players and identify any positional differences existing. Sixty three players from five different countries were measured in the 12th Asian Games in Hiroshima for height, mass, skin fold thicknesses and estimates of body fat and muscle mass. Results were compared with data for the English handball squad for reference purposes. Significant differences were evident among the Asian teams, the group from East Asia being taller and lower in adiposity than the teams from West Asia. A relative homogeneity was observed among positional roles. The more successful teams were taller and had lower body fat than the less successful teams. It is concluded that Asian handball players differ in anthropometric characteristics from European players previously studied and that specific anthropometric variables are associated with successful tournament performance at international level in Asia.

Buchheit, M. (2009) determine whether a 4-a-side handball (HB) game is an appropriate aerobic stimulus to reach and potentially enhance maximal oxygen uptake (VO$_2$ max) and whether heart rate (HR) is a valid index of during VO$_2$ a handball game. Nine skilled players (21.0+/−2.9 yr) underwent a graded maximal aerobic test (GT) where (VO$_2$ max) and HR-VO$_2$ relationship were determined. VO$_2$, HR and blood lactate ([La](b)) were recorded during a 2 x 225 s (interspersed with 30s rest) 4-a-side handball game and were compared to those measured during an 480-s running intermittent exercise (IE). Mean VO (2) tended to be higher in handball compared to IE (93.9+/−8.5 vs. 87.6+/−7.4% O (2) max, p=0.06), whereas HR was similar (92.3+/−4.9 vs. 93.9+/−3.9% of the peak of HR, p=0.10). [La](b) was lower for handball than for IE (8.9+/−3.5 vs. 11.6+/−2.1 mmol·L (−1), p=0.04). Time spent over 90% of VO(2)max was higher for handball than for IE (336.1+/−139.6s vs. 216.1+/−124.7s; p=0.03). The HR-V O(2) relationship during GT was high (r(2)=0.96, p<0.001) but estimated VO(2) from HR was lower to that measured (p=0.03) in handball, whereas there was no difference in IE. 4-a-side handball game can be used as a specific alternative to IE for enhancing aerobic fitness in handball players. Nevertheless, the accuracy of HR measures for estimating VO (2) during handball is poor.

The aim of this study Gil, S.M., & Gil, J. (2007) was to establish the anthropometric and physiological profiles of young no elite soccer players according to their playing position and to determine their relevance for the selection process. Two hundred forty-one (n=241) male soccer players who were members of the Getxo Arenas Club (Bizkaia) participated in this study. Players, age 17.31 (+/− 2.64) years, range 14-21 years, were classified into the following groups: forwards (n = 56), midfielders (n = 79), defenders (n = 77), and goalkeepers (n = 29). Anthropometric variables of participants (height, weight, body mass index, 6 skin folds, 4 diameters, and 3 perimeters) were measured. Also, their somatotype and body composition (weights and percentages of fat, bone, and muscle) were calculated. Participants

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performed the A strand test to estimate their absolute and relative VO2max, an endurance test, sprint tests (30 meters flat and 30 meters with 10 cones) and 3 jump tests (squat jump, counter movement jump and drop jump). Forwards were the leanest, presenting the highest percentage of muscle. They were the best performers in all the physiological tests, including endurance, velocity, agility, and power. In contrast, goalkeepers were found to be the tallest and the heaviest players. They also had the largest fat skin folds and the highest fat percentage, but their aerobic capacity was the lowest. In the selection process, agility and the jump tests were the most discriminating for forwards. In contrast, agility, height, and endurance were the key factors for midfielders. The defenders group was characterized by a lower quantity of fat. The study concludes that anthropometric and physiological differences exist among soccer players who play in different positions. These differences fit with their different workload in a game. Therefore, training programs should include specific sessions for each positional role.

Takeuchi, 26 (1988) compared physique and physical fitness of the national handball team players of Japanese national team (JH, n=17 men) with Yugoslavia (YH, n=15 men) (ranked first in Los Angeles Olympic) and West Germany (GH, n=15 men) (ranked second in Los Angeles Olympic) in Japan. Seven physique indices were measured: height, weight, girth of chest, upper arm (extended and bent), forearm, thigh, and calf. The functional indices of back strength, grip strength, and vital capacity were also measured. For height, weight, and girth of chest, upper arm (extended and bent) and of forearm JH players showed significantly lower values than YH and GH ones. As for the girth of thigh or of calf, all three team players showed about same values. For back strength JH and YH players showed almost the same values, which were significantly higher than those of GH. For vital capacity, YH and GH players showed significantly higher values than JH ones. The study concluded that in all physique indices, the players of JH evidently showed the values lower than those of the players of YH and GH, with two exceptions of the girth of thigh and of calf. For vital capacity, JH players showed also apparently lower values compared those of the YH and GH players. It is thus clear that the JH players should first of all improve in the body size by training, or it might be necessary to collect big players in

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In order to level up the great of the performance of the handball game, in comparison of the YH and GH players.

Prior to the Olympic Games in Atlanta, the United States tested the Olympic Team Handball players (n=20, ages ranged from 22.01 to 31.73 years) consisted of laboratory tests of maximum oxygen uptake, computerized strength measures, blood tests, etc., and a battery of field tests (anthropometrics: height, weight, hand breadth, arm length, arm span; and skills: accuracy throw, dribble and jump-throw) that included assessments of physical characteristics, and physical performance components. Bergmann, B. (1995) the mean vertical jump for the dominant leg was 54.03 cm (21.27 in), the non-dominant leg was 46.72 cm (18.39 in), and for both legs was 62.15 cm (24.47 in). This is higher than vertical jumps of 52.8 cm (20.8 in) for professional soccer players, 53.3 cm (21 in) for college basketball players, but less than 67.0 cm (26.4) for elite men volleyball players. The correlation coefficients for the anthropometric, vertical jump and the skills tests with the Experts Rankings were very low. The correlation between the Total Composite T-scores and the Experts Rankings were the highest with r = 0.364. This is not significant but was very close to the r = 0.3783 needed for significance.

Zapartidis, D. (2009) conduct a study titled, ‘Factors Influencing Ball Throwing Velocity in Young Female Handball Players’. Aim of this study was the investigation of the relationship between throwing ball velocity and specific anthropometric and physical fitness characteristics of young female team handball players (n = 220, mean ± SD age 13.99 ± 1.06 yrs and playing experience 3.66 ± 1.66 yrs). Throwing velocity was assessed with a radar gun while body height, body mass, body mass index, arm span, hand length and spread, standing long jump, 30m sprint, sit and reach flexibility and estimated maximal oxygen uptake were also measured. The results showed that throwing performance is significantly (p<0.05) correlated with all variables calculated in this study except of the body mass index. This suggests that high performance requires advanced motor abilities and anthropometric features for these ages.

The purpose of this study was Zapartidis, I., Gouvali, M., Bayios, I., Boudolos, K. (2007) to examine the influence of simulated game activities (SGA) in throwing effectiveness and rotational strength of the shoulder and the relationship between the rotational strength of the shoulder and ball velocity and accuracy in team handball. Sixteen female handball players participated following a SGA, which included distinctive handball activities for 60 min (2 halves of 30 min). For testing ball velocity and accuracy, every 10 min, subjects performed 3 shots on the spot towards a target from 7 m distance. Shoulder isokinetic strength during internal (IR) and external rotation (ER) was evaluated in 3 angular velocities (60, 180, and 300 degrees /s) before SGA, during half-time and at the end of SGA. Throwing effectiveness was significantly affected by time, as aiming accuracy was gradually decreased. However, ball velocity remained stable. The correlation between ball velocity and deviation was not significant throughout the SGA. No statistically significant differences between measurements were found in maximum isokinetic torque, except from the case of ER at 180 degrees /s, where there was a significant difference between initial measurement (IM) and A and B halves. A significant relationship between isokinetic torque and ball velocity was found only for the IM for ER (180, 300 degrees /s) and IR (300 degrees /s). The main findings of this study are that, during a game simulation, time affects only aiming accuracy and not ball velocity or rotational strength of the shoulder. Moreover, peak torque of IR and ER of the shoulder is not related with ball velocity and throwing effectiveness.

Granados, C., Izquierdo, M., Ibanez., J. Bonnabau, H., & Gorostiaga, E. M. (2007) examined sprinting performances in 16 elite and 15 amateur players. The elite players were 4% and 3% faster than the amateur players in 5-m (1.10[+ or -]05 vs. 1.14+03 sec) and 15-m (2.64[+ or -]09 vs. 2.71[+ or -]08 sec) sprints, respectively. The small gap between the achievements of the elite and the amateur players can be explained by the fact that the sprints were conducted in sterile conditions that did not reflect real-game situations. Under real game situations, when players are required to perceive the environment, anticipate an event, and make a decision, and only then

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perform as quickly as possible, the gap between elite and amateur players would likely be more distinctive. Similar to the previous study in a study of 53 players of the Croatian major team handball league, Cavala, M., Rogulj, N., Srhoj, V., Srhoj, L., & Katie, R.\textsuperscript{31} (2008) found better agility and speed performance in above-average players compared to average players. They assessed agility and speed using a number of tests, among them the shuttle-run test, sidesteps, and sprints for 20m, 30m and 40m.

Study examined changes in sprint performance over one team handball season In this study 16 elite players were examined, no differences were found in 15-m sprint performance throughout one season Granados, C., Izquierdo, M., Ibanez, J., Ruesta, M., & Gorostiaga, E. M. \textsuperscript{32} (2008). Since players devoted only .1-.3% of their practice time to sprinting or sprint training, this finding is not surprising. The researchers of this study stressed that more time should be dedicated to sprint training and leg muscle strength and power training, in order to increase sprint performance.

The importance of including sprint training and increasing speed is highlighted by the fact that elite players appear to be faster than amateur players; therefore speed is a critical element for team handball players. Similar study done by Jensen, J., Jacobsen, S. T., Hetland, S., & Tveit, P.\textsuperscript{33} (1997) examined maximal running velocity in eight world class team handball players. Maximal running velocity was tested for the final 10 m with photocells connected to a stopwatch, after they had run 20 m for acceleration. No data on the validity and reliability of this test were reported. Maximal running performance dropped from the early stages of the preparation phase (7.85[+ or -]24 m [s.sup.-1]) to the middle stages of the preparation phase (7.66[+ or -]25 m [s.sup.-1]), and increased just before the team's most important tournament of that year (8.02[+ or -]22 m [s.sup.-1]). The decrease in maximal running velocity during the middle of the preparation phase may have been related to a heavy resistance training program or to the resulting fatigue from training during this phase.


The increase in maximal running velocity toward the beginning of the most important tournament occurred despite a decrease in physical training, suggesting that tapering at that stage might be beneficial for increasing performance at the competition phase of the training program.

In another study Ronglan, L. T., Raastad, T., & Borgesen, A. (2006) assessed the effect of fatigue on 20-m sprint performance. They measured time using photocells at the 10-m and 20-m marks, and observed no differences in times in the 10-m mark and only minor differences in the 20-m mark during a training camp, as well as during an international tournament. During the tournament, over a course of three games played in three days, 20-m sprint performance was reduced by 3.7[+ or -]4%. Although this minor reduction was found to be significant, the authors argued that team handball performance, as observed during an actual game, is influenced by a number of physiological aspects, and therefore a minor reduction in only one aspect, such as sprinting, would not necessarily influence the overall performance of the female players. Only one study was found that compared agility and speed among elite players (n = 53) playing different positions.

In this study, Rogulj, N., Srhoj, V., Nazor, M., Srhoj, L., & Cavala, M. (2005) showed that wing players were faster and more agile than pivots and goal keepers. However, they reported no significant differences between wing players and back-court players in agility and speed. Speed was assessed using a 30-m run, and agility was assessed using tests such as the stepping aside test. Team handball wing players are usually required to be faster and more agile than other field players. These qualities of wing players were only partially demonstrated in this study, since the performance of back-court players was similar to that of wing players. No plausible explanations were offered for this lack of differences. However, the means for the speed and agility tests showed that wing players tended to be faster and more agile than back-court players. It is possible that the lack of statistical difference was due to a lack of statistical power. Unfortunately, the effect size could not be calculated from data presented in this study, since standard deviation values were not reported.


2.2. Review related to morphological variables.

In a study performed with adolescent team handball and volleyball players, Noutsos, Noutsos, K., Koskolou, M., Barzouka, K., Bergeles, N., & Bayios, I.\(^{36}\) (2008) found that team handball players were shorter (166.9[+ or -]4.7 cm) than volleyball players (175.2[+ or -]6.3 cm). However, adolescent team handball and volleyball players had similar body mass and FFM. In comparison, Hoffman, J.\(^{37}\) (2006) reported that the average height for 17-year-old American females was 163.2 cm. Therefore, adolescent team handball players were slightly taller than the average American female.

Kinanthropometry profile (weight, stature, sum of six skin folds, muscularity and vertical jump) of Brazilian (BCN Osaco female) volleyball athletes (age: 13 to 22 years) in 3 age groups: A-(13 to 14 yrs old), B-(15 to 17 yrs old), C- (>17 yrs old) with different training experience Gr.1 (0 to 2 yrs) Gr.2 (2 to 4 yrs) and Gr.3 (>5 yrs) were studies Silva, L.R.\(^{38}\) (2000) One-way ANOVA and post hoc (Tukey) tests were used for statistical analysis. Significant differences were observed for most of the variables studied among the age groups and between the shorter (Gr.1) and longer (Gr.3) trained groups.

The purpose of this study Can, F.\(^{39}\) (2004) was to describe certain morphological characteristics of women soccer players and to examine aspects of training and performance. Twenty-two anthropometric sites were used in measurements of somatotype 49 and body composition; flexibility, agility, anaerobic power, leg muscle power, and dynamic pulmonary functions were used as performance variables. Measurements were made on 17 professional athletes and 17 age-matched sedentary women who acted as controls. The women soccer players showed less fat content and less lean body mass than did the sedentary women. The mean somatotype for the soccer players was 3.07–3.55–2.43 and for the no athletes was 3.57–3.35–2.90. Anaerobic power, leg muscle power, and agility in the athletes were higher than in the non athletes, whereas no differences were found in flexibility and pulmonary

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functions ($p > 0.05$). The women soccer players showed more significantly mesomorphic, less endomorphic, least ectomorphic components and higher performance level than did the sedentary women.

**Anthony, F., & Plotz.** (2006) the aim of this study was to comparison of talented South African and English youth rugby players (18-year old) with reference to game-specific-, anthropometric, physical and motor variables. Three groups of elite rugby players were selected from the two countries and were tested on 13 anthropometric, six physical and motor and eight game-specific tests. The results showed that there are no big differences as far as anthropometric variables are concerned, the English players, however, significantly demonstrated the worst results in all the physical and motor abilities while the South African players performed the best in game-specific skills due to possible better coaching.

The anthropometrical characteristics and body composition of Greek woman volleyball players (age: 23.8 +/- 5.1 years) were examined by **Papadopopulou, S.D.** (2000) from the national team (NT, n= 29) and A1division (AD, n= 63). The measurements recorded were height, wt, segment lengths, diameters, circumferences and body fat percentage. The mean height was 179 +/- 62 cm and the mean weight 70.7 +/- 7.8 kg. The NT players had significant longer upper limb, forearm, bi-trochanteric diameter and wrist and calf circumferences (p<0.05). There were no significant differences in body fat percentage between NT (22.4 +/- 4.7 %) and AD (21.3 +/- 5.5 %) players, as well as fat free mass (56.1 +/- 5.7 kg and 54.6 +/- 4.7 kg for NT and AD, respectively). Some anthropometrical characteristics differ between NT and AD players and these characteristics could possibly affect the performance. In both NT and AD players relatively high body fat percentage is a negative factor in athletes’ top performance and must be decreased.

Measurements of body and limb composition of 43 Japanese professional baseball players were taken immediately after the competitive season **Yuichi, H.** (1988) Body composition was determined by densitometry. Body weight was seen averaged

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79.6±6.0kg with mean percent fat of 13.8±4.2%. They were within the male college student’s range in body fat, but higher lean body mass (68.4±4.0kg) even if the difference in body height between the two groups was taken into account. On 20 out of 43 baseball players, limb composition was determined by an ultrasonic method. All tissue cross-sectional areas (bone, fat, and muscle) of each segment in both upper and lower limbs were significantly greater for the baseball players than for the male college students. When estimating each cross-sectional area as a tissue / whole limb cross-sectional area ratio, flexor muscle in the forearm and in the thigh were observed to be highly developed in the baseball players than in the male college students. These results suggested that the game and / or training of baseball might require each player to possess an anaerobic working capacity and that instruments used in baseball such as a bat might affect limb composition.

Matsumoto, D.  (2000) Examined the relationship between performance and not only weight, but also lean body mass (LBM), muscle mass (MM), and total body fat (TBF) (as a negative factor) and also examined differences between selected competitive athletes and club members. One hundred and thirty six judo players from the all Japan University team Championships and all Japan elite judo athletes were separated into two groups, one involving competitive athletes (n1=40), and the other involving club members (n2=96). Body composition was measured using a Tanita TBF-305, which produced data on LBM and TBF. The results indicated that: 1) competitive athletes differed from club members on back strength, vertical jump, and push ups with claps. 2) Competitive athletes had significantly higher scores than the club members on LBM and MM; club members had significantly higher scores on the limiting factors of TBF and TBW. These results help to understand the importance of body composition in a competitive sports such as judo, and the importance of reducing body fat, increasing muscle mass, and improving basic physical fitness. Obviously, the findings are helpful for success in Handball also.

The investigators Ashok., & Babu.  (2000) undertaken this study at the south west intervarsity men tennis tournament held at Ayya Nadar Janki Ammal College

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Fifteen players were randomly selected and their anthropometric variables such as height and arm length were measured with the help of standardized devices. The accuracy was founded by seeing the percentage of getting success in the first serve during the competition. The collected data was statistically analyzed by using Pearson’s product moment correlation. The findings drawn after the statistical treatment revealed that there was 1) very low negative correlation between the height and accuracy in the first serve. 2) Very low negative correlation between the arm length and accuracy in the first serve. 3) Very less positive correlation between the height and arm length of university Tennis players.

Bose, K. (1987) Selected forty one (n=41) high school champion footballers between 14-17 yrs old by using purposive sampling technique. Among these, 13 were from Pannalal School, Kalyani, Nadia (District level players), 16 from Lake View High School, Madhya gram, 24-Parganas (state & national champion & winner of Subrato Mukerjee cup in 1985). Thirty six below par school –footballers were randomly selected from Nadia district & from these only 12 were again randomly selected as control group. Morphological characteristics viz., standing height, weight, length of lower extremities, chest, thigh & calf circumference were considered and standard procedures were adopted for the purpose. Reliability of data was assessed which is statistically accepted. The score of all 6 morphological profiles were analyzed by multivariate one-way system & for testing significance differences (non-parametric) chi-square test was conducted. From the result, it appears that all the 6 variables jointly responsible for the difference in morphological profile between state and district level footballers. Thus, morphological profiles probably play a vital role for achieving high-performance level along with skill status being a vital factor.

Sodhi, H. (1991) conduct a study titled, 'Kinanthropometric trends in selected Indian ball game players'. Anthropometric measurements taken on 116 athletes during the national games held in New Delhi, in November 1985. Anthropometrics measurements taken on each subject were those used by Heath and Carter for evaluating a somatotype of an individual. The data of the present sample have been compared with previous studies and also with those hockey players who participated in at Montreal (n=47), in basketball at Mexico (n = 63) and volleyball at Montreal.
(n=130) Olympic Games. In each group, the players have been compared with the Olympians as well as the Indian players reported already. In about a decade the results of the study showed a trend of improvement in the body size of Indian players were still shorter in size, relatively lighter in weight and power in the development of mesomorphic comment of somatotype. Further, greater predominance of ectomorphic component was still persistent in these Indian sports.

2.3. Reviews related to Fitness and Performance.

Calderia., & Mastudo.\textsuperscript{47} (1988) analyze the changes on the physical fitness variables in elite volleyball players. The athletes from the 1987 national Brazilian team were submitted to a battery of tests. Data from each athlete included: weight, height, skin fold thickness, arm and calf circumference, predicted VO2 max (min)-1 and ml. (kg min)-1 (ml), 40 sec run test, 50 m run test, vertical jump with and without the help of arms, long jump and shuttle run. Data were compared to the national volleyball team who had participated in the 1980 Olympic Games in Moscow. The results showed a better situation of the 1984 Brazilian Olympic team in muscle mass; velocity (50m); aerobic (VO2) and anaerobic (40 sec) power.

Shergill.\textsuperscript{48} (1992) established the importance of a set of specific physical fitness components as contributors in hockey playing ability. On the basis of available literature, 22 relevant test items were selected to measure fitness components. The sample consisted of 100 female hockey players, from 4 universities of Punjab. The age of player’s ranged between 18 to 24 years. The stepwise regression was applied to assess the importance of different variables in predicting hockey playing ability. The result of ‘t’ ratio suggested that endurance run test, standing broad jump, grip strength (LH), vertical jump, wrist flexion, age, height, and weight were significantly important in evaluating the hockey performance. Also, the results failed to find support for speed as an important predictor of hockey playing ability. The result of this analysis again stresses the positive role of physical fitness components in hockey playing ability.


Cicirko, L., Scott, D., Bennett, P., & Hodson, A. (2007) conduct the study entitled, ‘The General and special physical fitness level in young football players.’ The objectives of the study to defined the level of general and special physical fitness of football players in the key stage of football training, transition from learning training and investigate the correlation between general and special fitness of young football players and their playing position. Twenty selected football players with 6 year training experience constituted the subjects of the study. International fitness test was used to evaluate general physical fitness and football abilities test was used to evaluate special fitness. According to the classification of international fitness test norms the players were placed in the 320-480 points bracket, that’s defined their general physical fitness as medium. In the special fitness test the strikers definitely dominated, whereas the defensive players gained the poorest results, spearman’s rate correlation indicated statistical significance (p<0.05) in some test.

Singh. (1997) assessed the performance and fitness of 11-14 years old swimmers according to German standards. Data was collected on 160 swimmers (80 boys and 80 girls) by conducting a battery of tests (50m free style, 50m back stroke, 50m breast stroke, 50m butter fly, 60sec chin up, 60sec sit up, 30sec jumping sideways over the bench, 60sec push up, 60sec upper body lift, 60m dash, and 2000m run) used in Germany. The results revealed that Indian swimmers are much inferior to their German counterparts and swimming performance of Indian girls is very poor. On the whole the study indicates that the training and competition system for young swimmers needs comprehensive revaluation and change.

The purpose of the present study Stanley. (1999) was to profile competitive junior female tennis players and determine if differences in fitness exist between state (n = 13, age=16.23 yrs) and district (n = 10, age = 17.10 yrs) standard female tennis players. The fitness components measured included: maximal aerobic capacity (graded treadmill test to volitional exhaustion with direct oxygen analysis), strength (grip strength), power (vertical jump), speed (20 yard dash), muscular endurance

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51 Stanley, M. (1999). Fitness profiling and comparisons between different standards of competitive junior female tennis players. 5th IOC World Congress on Sport Sciences with the Annual Conference of Science and Medicine in Sport, Sydney, Australia.
(60-second sit-up), agility (spider test), flexibility (sit and reach) and body composition (restricted anthropometric profile). A questionnaire was also administered to determine fitness training habits and attitudes to fitness. A series of unpaired t-tests found no significant differences between the groups on any of the body composition or fitness variables. The only significant difference occurred with the subjects playing age where the state group had been playing tennis for a significantly longer time (8.46 yrs) than the district group (6.55 yrs). The results of the present study showed that the fitness level of the girls was sub-standard. This may partly explain the current lull in the performance of Australia’s female tennis players. Questionnaire results showed that most girls were spending considerable time doing fitness training each week however, the questionnaire also showed that most of the girls did not have a fitness program to follow and would like a program written for them. To succeed at the highest level the tennis player must be proficient in all three areas of skill, psychology and fitness.

Graetzer., & Shultz. 52 (1995) assessed aerobic and anaerobic power and capacity, muscular strength, flexibility, balance, and blood chemistry status on ten male, competitive, open-class handball players (40.22 +/- 5.85 yr, 182.19 +/- 6.95 kg, 1.0654 +/- .0147 gm.mL-1, and 14.70 +/- 6.48 percent body fat). Peak treadmill oxygen uptake and heart rate averaged 44.69 +/- 6.47 (range, 57.30-33.69) ml.kg-1 m-1 and 177.50 +/- 8.26 (193-168) bpm with the ventilatory threshold occurring at 87.45 +/- 6.34 (97.01-76.03) percent of aerobic max. Leg Wingate peak anaerobic power was 728.24 +/- 94.87 (847.1-582.4) w, 9.22 +/- 0.95 (10.7-7.8) w.kg-1, and 10.87-1.43 (12.9-9.0) w.kgFFW-1 and power decline was 34.25 +/- 8.24 (50.0-22.2) %. Arm Wingate peak anaerobic power was 450.59 +/- 56.03 (517.7-376.5) w, 5.48 +/- 0.52 (6.2-4.8) w.kg-1, and 6.45 +/- 0.74 (7.5-5.3) w.kgFFW-1 Arm Wingate mean anaerobic power was 368.24 +/- 26.82 (400.0-329.4) w, 4.49 +/- 0.32 (4.6-4.1) w.kg-1, and 5.28 +/- 0.40 (5.8-4.7) w.kgFFW-1, and power decline was 34.49 +/- 6.59 (45.5-25.0) %. Standing vertical jump height was 50.93 +/- 7.27 (58.4-33.0) cm and right and left grip strength was 52.90 +/- 4.95 (62-47) kg and 52.70 +/- 4.72 (60-46) kg, respectively. Flexibility measures included: sit and reach, 29.95 +/- 9.95 (43-13) cm; shoulder rotation, 89.15 +/- 11.36 (106.7-71.1) cm; and bridge up trunk extension, 47.69 +/- 13.78 (73.7-29.2) cm. Sagittal stabilometer time in balance (average six 20-second trails at 3

degree error setting) was 7.41+/−2.16 (10.53-4.94) sec whereas time out of balance right and left were 7.11+/−1.58 sec (9.58-3.66) and 5.48+/−1.30 sec (7.11-2.93), respectively. Blood lipids were: total cholesterol, 197.80+/−26.78 (234.16) mg.dL-1; HDL-C, 47.40+/−10.64 (72-31) mg.dL-1; LDL-C, 128.90+/−16.74 (155-111) mg.dL-1; VLDL-C, 21.50+/−12.12 (25-11) mg.dL-1, and total cholesterol / HDL-C RATIO, 4.29+/−0.77 (5.78-3.25). red blood cell and iron status revealed: hemoglobin, 16.00+/−0.60 (16.9-14.9) g.dL-1; serum iron, 173.00+/−37.85 (192-70) mcg.dL-1; TIBC 347.40+/−63.2 (429-279) mcg.dL-1; transferring saturation, 32.50+/−10.12 (58-22)%; serum ferritin, 147.50+/−55.28 (219-27) ng.ml-1; hematocrit, 47.33+/−1.71 (50.1-44.2)%; total RBC count, 5.25+/−0.29 (5.80-4.81) k.ml-1; MVC, 90.28+/−2.01 (92.4-85.6)ft; MPV, 8.96+/−0.58 (9.6-7.8) ft; MCH, 30.52+/−0.66 (31.2-29.1) pg; MCHC, 33.79+/−0.41 (34.4-33.1) g.dL-1; and RDW, 12.67+/−0.47 (13.8-12.2) %. Sports profiling, an important recent development in sports physiology, had not previously been reported for handball players although has been rated as the top fitness developing activity by the President’s Council for physical fitness. Sports specific physiological data is useful to predict performance success, compare athletic groups, assess improvement throughout phases of conditioning, provide baseline measures to monitor rehabilitation following injury, prevent over training, as a pathological screening tool.

**Guner, Kunduracioglu, Ulkar, & Ergen.** (2005) had undertaken a study to examine the endurance performance of elite soccer players, according to age and playing position. A total of 197 male soccer players participated in this study. Each player performed exercise tests on the treadmill that included 3-minute runs and 30-second blood sampling intervals. During these tests, running speeds at the first and second stages were 10 km/hr -1 and 12 km/hr -1, respectively. When these tests were completed, running speed was increased by 1 km/hr every 3 minutes until the runner reached exhaustion. Blood samples were analyzed immediately by means of an automated lactate analyzer. Heart rate was monitored continuously at 5-second intervals. Running velocities and heart rates at 2-mmol/L -1, 2.5-mmol/L -1, 3-mmol/L-1, and 4-mmol/L-1 blood lactate concentrations were calculated with use of the spline function. Analysis of variance was used to analyze data to determine the

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differences between playing positions (goalkeepers, defendants, midfielders and forwards) and age groups (older than 30 years of age, between 25 and 29 years old, between 20 and 24 years old, and 19 years old and younger). Statistical significance was set at \( P < 0.01 \). No significant were revealed between defenders, midfielders, and forwards regarding running velocities and heart rates and their correlation with specified lactate concentrations. Goalkeepers demonstrated lower endurance performance than players in the other playing positions (\( P < 0.011 \)). Running velocities corresponding to all lactate concentrations showed no significant differences in all age groups, but heart rates in soccer players older than 30 years of age were significantly lower than those of players in other age groups (\( P < 0.01 \)). Results of this study suggest that the endurance performance level of professional players is similar for players in all positions, except for goalkeepers, and that endurance performance is not adversely affected when a person’s age increases beyond 30 years of age.

Mohr., Krstrup., & Bangsbo\textsuperscript{54} (2003) assessed physical fitness, match performance and development of fatigue during competitive matches at two high standards of professional soccer. Computerized time-motion analyses were performed 2-7 times during the competitive season on 18 top-class and 24 moderate professional soccer players. In addition, the players performed the Yo-Yo intermittent recovery test. The top-class players performed 28 and 58% more (\( P < 0.05 \)) high-intensity running and sprinting, respectively, than the moderate players (2.43 +/- 0.14 vs 1.90 +/- 0.12 km and 0.65 +/- 0.06 vs 0.41 +/- 0.03 km, respectively). The top-class players were better (11%; \( P < 0.05 \)) on the Yo-Yo intermittent recovery test than the moderate players (2.26 +/- 0.08 vs 2.04 +/- 0.06 km, respectively). The amount of high-intensity running, independent of competitive standard and playing position, was lower (35-45%; \( P < 0.05 \)) in the last than in the first 15 min of the game. After the 5-min period during which the amount of high-intensity running peaked, performance was reduced (\( P < 0.05 \)) by 12% in the following 5 min compared with the game average. Substitute players (n=13) covered 25% more (\( P < 0.05 \)) ground during the final 15 min of high-intensity running than the other players. The coefficient of variation in high-intensity running was 9.2% between successive matches, whereas it was 24.8% between different stages of the season. Total distance covered and the distance covered in

high-intensity running were higher (P<0.05) for midfield players, full backs and attackers than for defenders. Attackers and full-backs covered a greater (P<0.05) distance in sprinting than midfield players and defenders. The midfield players and full-backs covered a greater (P<0.05) distance than attackers and defenders in the Yo-Yo intermittent recovery test (2.23 +/- 0.10 and 2.21 +/- 0.04 vs 1.99 +/- 0.11 and 1.91 +/- 0.12 km, respectively). The results show that: (1) top-class soccer players performed more high-intensity running during a game and were better at the Yo-Yo test than moderate professional players, (2) fatigue occurred towards the end of matches as well as temporarily during the game, independently of competitive standard and of team position; 3) defenders covered a shorter distance in high-intensity running than players in other playing positions; (4) defenders and attackers had a poorer Yo-Yo intermittent recovery test performance than midfielders and full-backs; and (5) large seasonal changes were observed in physical performance during matches.

Meitei.\textsuperscript{55} (1996) attempted to explore the area of physical fitness and technical skill as possible reasons of the poor performance of Indian women shot-putters. The study was conducted on 25 women shot-putters of national, university and state level. The performance of the Indian women shot-putters was compared with the equivalent norms and found that the athletes are poor in technical efficiency, specific strength, specific and general speed and explosive strength. It was also found that maximum strength level is above the norms. But its conversion to explosive strength is poor. The following tests were conducted to collect the data. Bench press, clean, squat, shot put standing (5 kg), shot put pull action (3 kg), 30m dash, shot-put standing and shot-put pull action (4kg) techniques, standing long jump, triple jump, and hops were suggested.

Mood.\textsuperscript{56} (1971) conducted a study of two forms of the test of physical fitness knowledge of senior physical education for major students. One hundred and eighty four experimental test items, the contents of which were based on 60 physical fitness facts Secured from recent physical education literature and on the opinions of 73 members of the Research Council of AAHPER, were administered to 1,360 physical education major students enrolled in 35 collegiate institutions in the United States. As


a result of item analysis data, two parallel forms of the tests were constructed. For the purpose of obtaining validity and reliability of data and establishing national norms the two final test forms were administered to 4,167 students enrolled in 150 collegiate institutions in the United States. Two forms of the test of physical fitness knowledge were constructed so that growth in comparison of physical fitness can be analyzed.

Richardson.\textsuperscript{57} (1977) studied the relationships between grip strength, wrist flexion, arm length and the velocity of a thrown baseball in male high school varsity baseball players. The purpose of this study was to determine if grip strength had significant relationship to throwing velocity etc. Ss were 31 high school varsity baseball players, currently in regular season play. Grip strength was measured with dynamometer. Data obtained were then analyzed by a multiple linear regression. The study concluded that grip strength had a significantly positive relationship to baseball throwing velocity.

Muzumdaar & Edwin.\textsuperscript{58} (2000) selected male basketball players (n=180) in mini, youth, and junior category of Bombay region. Standard tests for testing the variables viz., vertical jump for leg power, 30m dash for running speed, agility, 12min run and walk for C.V. Endurance were administered in the players. The basketball playing ability was graded (out of 10 points) by a panel of three qualified judges during the competition and the average of three judges was considered as the subjects playing ability. The relationship of physical fitness variables and playing ability was established by computing Pearson’s product moment correlation coefficient. Using ‘t’ test did comparison for mini, youth, and junior playing ability group. The result reveals that - 1) There was positive relationship between 30m dash and under basket shooting for the junior group. 2) Relationships between other physical fitness variables and basketball playing ability for the three groups were not significant 3) Mini group has a significant higher relationship between playing ability and 30m dash than the youth group. 4) The youth group has a significant higher relationship playing ability and endurance than the mini group.


Bayios, I. A., Bergeles, N. K., Apostolidis, N. G., Noutsos, K. S., & Koskolou, M. D. (2006) described differences between team handball, basketball, and volleyball players in a large sample from the first national leagues in Greece (Divisions A1 and A2) consisting of 222 team handball players, 133 basketball players, and 163 volleyball players. The team handball players were shorter and had a lower body mass, higher percent fat, and lower FFM than the basketball and volleyball players. The authors of this study suggested that in team handball, height was probably not a criterion for selection of athletes, as their mean height was not different from the norms of Greek women.

A time-motion analysis conducted by Manchado, C., Navarro, F., Pers, J., & Platen, P. (2008) on 25 elite team handball players found a mean HR of 86% of HRmax throughout a game. Heart rate was higher than 85% of HRmax in 90% of the playing time. While goalkeepers had lower HR values, no differences in HR were found among players playing field positions. In addition, HR values during the first half were higher than those in the second half. These HR values, which probably were above the anaerobic threshold of the players, suggest that the anaerobic metabolism supplied much of the energy requirements during the game. Players covered a distance of 4,614 m during one game (Manchado et al., 2008), with large variations ranging from 2,066 m in goalkeepers to 5,251 m in field players. The running distance per minute was low in goalkeepers (31.3 m*[min.sup.-1]) and high in field players (69.7 m*[min.sup.-1]), with no significant differences among players in field positions. In addition, the running distance per minute was lower in the second half (65.1[+ or -]18.0 m*[min.sup.-1]) compared to the first half (71.5[+ or -]7.2 m*[min.sup.-1]). Interestingly, players with a higher endurance capacity were able to perform more intense activities compared to players with a lesser endurance capacity, although they maintained similar HR and HRmax. The authors of this study suggested that female team handball players with a higher V[0.sub.2]max were able to use more aerobic metabolism (Manchado et ah, 2008). Hence, coaches should include aerobic training that emphasizes the improvement of V[0.sub.2]max in the training schedule.

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of their players. For example, high-intensity interval training can be conducted during pre-season conditioning. During the season, sub-maximal tests can be conducted to ensure the maintenance of $V_{[0.\text{sub.}2]} \max$.

Michalsik, L.\textsuperscript{61} (2008) followed 24 Danish elite players from 2002 to 2006. The average physiological load during tournament matches corresponded to 79% of $V[0.\text{sub.}2]\max$. The players covered an average distance of 4.0 km. Each player averaged 27 high intensity plays during a game. In total, up to 700 changes of activity were observed during a game, based on eight movement categories. Wing players and pivots covered more distance than back-court players (4,063 m and 4,050 m vs. 3,866 m, respectively). However, in light of the distance-covered values (i.e., 2066-5251 m) found by Manchado et al. (2008), the practical significance of these differences is unclear. Wing players also engaged in more high intensity work (3.56% of total distance covered) than back-court players (1.35%) and pivots (2.32%). On offense, wing players received less tackles (7.5 per match) than back-court players (15.9) and pivots (25.4). On defence, wing players performed fewer tackles (11.8 per match) than back-court players (24.6) and pivots (27.4). Wing players also engaged in more quick runs (4.4 per game) compared to back-court players (1.35) and pivots (2.47). In summary, wing players did more high intensity work, covered greater distances, and engaged in fewer tackles than both back court players and pivots.

2.4. Review related to Skill, Tactics and Performance.

Battles, J.\textsuperscript{62} (1980) investigated the prediction equation for selection of intercollegiate basketball team members. Subjects for this investigation were 33 females who were participating in women’s basketball at three colleges in Florida; all were members of the FAIAW. Each subject completed a personal data form, the AMI, the Knox basketball test, Sargent jump test, and the field goal speed test. Selected anthropometric measurements were also obtained from each subject. Results of step-wise multiple regressions indicated that players ranked high by head coaches tended to score high on a combination of physical and psychological variables.


Cox, R.H.⁶³ (1974) established the relationship between selected volleyball skill components and team performance of men’s Northwest “AA” volleyball teams. A purposive sample of 107 games between the best “AA” men’s teams in each of 9 northwest volleyball tournaments was charted. The results of the study indicated that; consider together, the volleyball skills studied was significantly related to team performance. Further analysis of nature of the relationship revealed that the order of the volleyball skills most influential in predicting team success.

Brown.⁶⁴ (1989) investigated relationship of physical characteristics, physiological capabilities, and nutritional habits to female basketball team selection. 27 female from the University of Wisconsin-La Crosse participated in this study. Nutritionally, diets were analyzed. Physiological parameters examined were % body fat, lean body mass, VO2 max, anaerobic power, and vertical jumping distance. Physical parameters including age, height, weight was measure. It was concluded that, at the University of Wisconsin-La Crosse, physiological capabilities, and nutritional habits were not a major factor in team member selection.

Shohei, K., Takahiko, N., Seji, O., & Yoshiyuki, M.⁶⁵ (1988) established the performance probability curve of some skill in athletics. In this study large sample (N=295) have been collected on athlete on short distance run, jumping and throwing events. Data were arranged by time series in each athlete, and measure of central tendencies and variability were calculated with every successive data based upon normal distribution. Probability of records around mean was calculated with given SD. These probabilities were collected in each record, and tried to fit logistic function to them. Standard error of estimate was evaluated for each compared between the athlete pf some even. The study calculated that 1) Proper application of logistic function was of 35 cases among 152 athletes who had enough data to apply logistic function. These curves did not cross each other, and the intervals between the curves were almost same. 2) Standard error of estimate for proper application was about 0.05. 3) Error was greater in record which had only low probability. 4) Development constant, Denominator involved in logistic function was different significantly among

the athlete to the same event. 5) It was supported that the maximal slope of the curve was one of the indices representing one’s own athletic ability of each athlete.

**Hoare, D. G., & Warr, C. R.** *(2000)* used a quasi-applied research model to identify and develop potentially talented female soccer players. Athletes aged 15-19 years with a background in team ball sports or athletics were targeted for recruitment using advertisements and promotions through various media. Interested athletes attended a 2-day programme of testing, which included assessment of anthropometric, physiological and skill attributes. A combination of factors was used in the final selection of 17 athletes to take part in a 12-month talent development programme. A pre-season programme of five training sessions per week was conducted for 2 months. This programme focused on enabling the players to acquire the necessary ball and game skills to perform competitively in a short time. The squad competed as a team in the reserve grade competition of an Australian state league. At the conclusion of the 25-game season, 10 players were selected for zone teams with two players progressing to state team selection within 6 months. The project demonstrates that it is possible to select potential female soccer players based on anthropometric, physiological and skill attributes. Selection procedures could be enhanced through the development of objective assessment tools that measure tactical and technical competence. Programmes such as this can offer an additional avenue of player recruitment in support of existing procedures.

**Rudi, M., & Robert, N.** *(2001)* conduct the study entitled, ‘Physical Fitness Qualities of Professional Rugby League Football Players: Determination of Positional Differences’. A total of 146 professional rugby league football players, contracted to 2 teams competing in England (n = 45) and Australia (n = 101), participated in this study. All players completed the following series of physical fitness performance tests: 1 repetition maximum squat and bench press, 15m and 40m sprint, agility run, 5 minute run for distance, 60 second sit-up, 30 second Plyometric push-up and measurement of body weight and subcutaneous Skinfold (4 sites). Analysis of variance with a criterion α level of $p < 0.05$ was used to determine if any significant difference could be found when grouping players into 3 different positional categories.

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typically identified in the sport. There were a 54 number of significant differences with respect to test results between categories, and this was apparent for all 3 systems of categorization. On the basis of these findings, we recommend that to more efficiently structure the physical fitness training of players, the players should be grouped either according to the 2 broad positional categories of forwards or backs or according to the 4 categories of forwards, distributors, adjustable, and outside backs. Grouping players according to the 9 specific positions played on the team is not warranted.

**Uppal, A. K. & Datta, A. K.** (1988) identified motor fitness components, which can help in prediction of performance in hockey. Male hockey players (n=74) studying in different universities of India was exposed to motor fitness components: Speed (50-yard dash), strength (right and left hand grip), Power (standing broad jump), Agility (dodge run), Dynamic balance (Johnson modification of Bass test), Flexibility (trunk and shoulder) and kinaesthetic perception (a test of horizontal distance). The criterion measures were playing ability in hockey, which was based on the Strait field hockey rating scale. The analysis of data using zero order and multiple correlations revealed that playing ability in hockey is significantly related to speed (r=-0.29), right grip strength (r=0.29), left grip strength (r=0.47), agility (r=0.30), balance (r=0.27), and kinesthetic perception (r=0.29). Playing ability in hockey is not found to be significantly related to power (r=-0.19), flexibility (r=-0.10), and shoulder flexibility (r=-0.16). The analysis of data further revealed that the combined contribution of left grip strength, balance and speed to playing ability in hockey is significant at 0.05 level of confidence. Conclusion: 1) the motor components, namely speed, grip strength, agility, balance, and kinaesthetic perception contribute to playing ability in hockey where as power and flexibility do not underlie performance in this game. 2) Speed, left grip strength and balance taken together, contribute most to the playing ability in hockey. 3) It is possible to predict playing ability in hockey based on performance in selected motor fitness components. Motor abilities required for football players (n=97; age :16-19 years) of age with the aim of assessing their motor abilities required for football players The following tests were conducted; 300 yards run, forward bending, bridge, throw-in, agility run without ball, sit up, 3 consecutive

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hops and 2.4km run. The results show that there are no significant differences in the motor abilities among the football players of various age groups. On the whole football players were found to be wanting in speed endurance and agility, but were found to be good in endurance. In the test of speed endurance they took 50.15 seconds to complete 300 yards. For agility run they took 25.34 seconds to cover the distance of 56 meters in different specified manners. In endurance test the time taken was 587.39 sec (+/-43.39 sec) while referring the norm laid down for national level players the values obtained in endurance tests are considered in the satisfactory category. Performance in the test of trunk flexibility was also above average. In the test of leg strength the left leg is found too stronger than the right leg. Forward players show superiority in the tests for agility without ball and speed endurance. Goalkeepers are equally good in a basic endurance and also possess high degree of trunk flexibility. Defenders did not show superiority in any test but are not considered to be poor in any test.

2.5. Review related to Test Battery and Norms.

Waghchoure, M.T. & Bera, T.K. 69 (2000) constructed and standardized a new battery of kho-kho skill test. Two thousand (n=2000) school boys, aged from 11-14 years, from Pune city, India, were pooled as a sample and were tested by the ten items of the preliminary form of the skill test. The data were processed through items analysis which assured the existence of ten items in the test. The test-items were then arranged on the basis of the analysis of item difficulty. The scoring principles of each item were also established scientifically. Te test-retest reliability co-efficient of this test was found statistically significant (r= 0.85, p < 0.01). This battery also assured its content validity. Both the percentile and t-scale norms were established on Likert’s five-point scale. The overall results revealed that this test can assess the kho-kho skills and predict potentially of the players with sufficient reliability and validity.

In a doctoral research Wangwad, V. S. \textsuperscript{70} (2001) assessing and evaluating the morphological variables (i.e. height and weight), physical fitness (i.e. speed, leg power and agility), and skills of volleyball, establish a standardized norms for selection of junior volleyball team of state level. The male volleyball players (n = 272) below the age of 18 years participated in Maharashtra state volleyball championship in 1998 were the subjects of this doctoral study. This ensures that 100% population was covered in this study. Standard procedure was followed to conduct test items for the collection of data. Standing body height (cm), body weight (kg), fifty-meter dash (speed), 4x10m shuttle run (agility), jump and reach (leg power), and volleyball skills (i.e. under hand pass, upper hand pass, serving, reception and service, set for spike and smash) were measured by using standard tests. The selection criteria as developed and standardized in this investigation is a reliable and valid, tests that can be objectively assess the efficiency of volleyball players to get entry in state level junior volleyball team. The norms of the selection criteria were easy to grade that can discriminate talented volleyball players with optimum accuracy so as to constitute a standard junior volleyball team.

The purpose of this study D’souza, S. \textsuperscript{71} (1993) was to standardize norms for physical fitness tests for in the age group of 13 to 16 years in the state of Goa. The physical fitness components considered for this study are strength (vertical and standing broad jump), muscular endurance (flexed arm hang), C. V. endurance, agility (4x10m shuttle run), and flexibility (bend, touch and twist). The researcher propose to administer the test to about 4000 girls in the age groups of 13, 14, 15, and 16 years, taking about 1000 girls in each age group, from about 75 schools of all the 11 Talukas in Goa. Seven test items in the test battery were split up into two sets and were conducted on two consecutive days. The data collected on the subjects in respect of different physical fitness items, was utilized for constructing the Percentile scale, Sigma scale, and Hull scale. T-test employed for comparing subjects representing different age groups in various test items considered in the study. The level of significant was set at 0.05 level of confidence. There is no significant difference in the physical fitness of the girls (13 to 16 yrs.) from the state of Goa.


\textsuperscript{71} D’souza, S. (1993). Standardization of norms for physical fitness tests for girls in the age group of 13 to 16 years in the state of Goa. Unpublished Doctoral thesis in Physical Education, Pune University, Pune, India.
belonging to the 15 years age group were found to be significantly superior to that of 13 years age group in vertical jumping ability.

**Dey, S. K., & Debray, P.**\(^{72}\) (1998) conducted study on Eastern (ER) and North-East (NER) region children to see the variations of these norms with the Indian norms, which are being used for talent identification throughout the country. In the present investigation percentile norms of various anthropometric and motor quality variables were made from the sample of children of ER and NER of India. These norms were compared with the existing national norms for Indian children sports performance of the children of ER and NER in the national context. The percentile norms thus formed for ER and NER children are of great importance particular in talent spotting in these regions. These norms also provide relative chance of getting talented children in sports from the regions. It was observed that ER children’s are relatively more talented than their NER counter parts. The children of NER may reveal better scores in the specific skill test exploiting their mesomorphic qualities.

**Dr. P. Purashwami**\(^{73}\) (2010), the purpose of this study was to construct the norms for evaluating performance of players in Table Tennis Skill Test. Since, there is a lack of standardized evaluative criteria in Table Tennis for assessing the ability, grading and predicting the performance of Table-Tennis players, an effort was undertaken to construct Norms for Skill Test for junior and senior Table Tennis Players. For this purpose 816 male, 410 Junior and 406 Senior, state and national level Table-Tennis players of different states in India were randomly selected to serve as subjects. The performance of Table Tennis players in Table Tennis test battery of four test items, Namely, Alternate Push Test, Target Service Test, Alternate Counter Test and Fore Hand Drive on Target Test with foot movement after playing backhand push, constructed by Pushpendra Purashwani and Dr. A.K. Datta, was chosen for the purpose of the study. The data was collected by administering the test for the selected test items during the Summer Coaching Camps and Regular Training Sessions of various districts, different Ranking Table Tennis Tournaments and State and Inter-District Table-Tennis Championships in the year 2006. The data, which was collected by administering tests, was statistically treated to develop norms for all the test items.

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The two normative scales, namely, the Percentile Scale and 7 Sigma Scale were constructed for the junior and senior table tennis players of state and national level. The norms were constructed by using Percentile and 7 Sigma Scale techniques analyzed through statistical packages, the scores were further classified into five grades i.e. very good, good, average, poor and very poor under Normal Distribution.

**Zuti, W. B.**\(^74\) (1977) prepared physical fitness norms for college freshmen. The age group selected for this was from 17.6, 18.5 to 19.5 years from freshmen of Kansas State University. The total subjects were 3000. The test was conducted for strength test, flexibility body composition, and cardiovascular fitness. The result shows that the college freshmen at Kansas State University were above average and standards were appropriate for their use at National level.

**Yadav, B.S.**\(^75\) (1986) conducted a study on standardization of physical fitness norms of the school children of Haryana (13 to 16 years of age) with the purpose of estimating the fitness level, establishing the norms for physical fitness and comparing the standard of physical fitness of urban and rural boys of Haryana. For the purpose of this study 3600 school boys of the twelve districts of 87 Haryana were randomly selected and the performance of the boys was recorded on 50 mt dash, shot put, standing broad jump, zigzag run, sit-ups and step test. The norms in terms of percentile rank of said group were developed.

**Watson, R.E.**\(^76\) (1978) established norms for Nebraska boys and girls. The tests selected for Neb Eel physical fitness test were standing long jump or vertical jump, 50 yard dash, sit-ups, stick jump and 300 yards distance run. The tests for secondary test were pull-ups or flexed arm hang, 50 yard dash, standing long jump, sit-ups, side step and mile or 9 minute run or 12 minute run. The sample was selected randomly. One-percent sample was selected from Neb schools to establishment of norms. The norms were established for each test for girls, boys and groups according to chronological age. Percentile statistic was used. According to result the following recommendations were suggested.

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\(^76\) Watson, R. E. (1978). The Establishment of Norms for Nebraska Physical Fitness Test. *Completed Research in Health, Physical Education and Recreation* 19, p.103
Sittmann, L. E. (1981) prepared norms for Northeast Missouri State University students of health and physical fitness concept classes. In which 372 male and 648 female subjects were tested. The test conducted was the sum of 6 skin folds, predicted percent fat, predicted VO2 max, grip strength; leg strength, back strength, vertical jump distance and vertical jump power. Statistic used was mean, standard deviations and range of all variables. Classification 85 was based on sex. Percentiles in increments of 5 were constructed for each variable in each classification.

Roche, D. P. (1971) examined the performance of 12811 boys and girls aged 7 to 17 in 9-minute run/walk test for students aged 7 to 10 and a 12-minute run/walk test for students aged 11 to 17; scores from this test were percentile ranked according to age and sex, and were presented for was as a field test of running endurance.

Rasmussen, G. L. (1970) found that the median scores of South Dakota boys at all ages were higher than of the National sample in all tests except pull-ups and shuttle run. After extensive experimentation involving 35 different test items,

Piscopo, J. (1962) conducted a study to establish norms and to compare skin fold and other anthropometric measurements of pre-adolescent boys from three ethnic groups. The subjects were 647 Italian, Jewish and Negro pre- adolescent boys. The skin fold was measured at five sites. Other measurements included height, weight, bi-iliac dimensions and selected girths. Co-relations were determined between skin folds and selected body build components. Skin folds ranged from moderate to high values. The largest percentile scores were found in Jewish groups. Analysis of variance was employed to compare body fat, height and weight of each group. Significant differences between ethnic groups were found in certain skin folds and weight at 0.01 levels.

Mistkawi, J.J. (1966) in his study prepared the national norms for the one minute basketball throw for goal, pull-ups, potato race, standing hop-step and jump, push-

78 Roche, D. P. (1971). Development of Norms for Run/Walk Minute Run/Walk Test to Young Males”, Research Quarterly, 42, p.54
80 Piscopo, J. (1962) Skin-fold and other Anthropometric Measurements of pre- adolescence boys from three ethnic groups. Research quarterly 33 ,p.255- 296
ups, standing broad jump and softball target throw items of the YMCA national athletic achievement programme. YMCA throughout the United States tested 2000 boys in each group, and the author obtained five percent of the scores at the Salem YMCA Oregon.

Keogh J.W.\textsuperscript{82} (2003) The purpose of the present study was to develop an effective testing battery for female field hockey by using anthropometric, physiological, and skill-related tests to distinguish between regional representative (Rep, \( n = 35 \)) and local club level (Club, \( n = 39 \)) female field Hockey players. Rep players were significantly leaner and recorded faster times for the 10-m and 40-m sprints as well as the Illinois Agility Run (with and without dribbling a hockey ball). Rep players also had greater aerobic and lower body muscular power and were more accurate in the 74 shooting accuracy test, \( p < 0.05 \). No significant differences between groups were evident for height, body mass, speed decrement in 6 x 40-m repeated sprints, handgrip strength, or pushing speed. These results indicate that %BF, sprinting speed, agility, dribbling control, aerobic and muscular power, and shooting accuracy can distinguish between female field hockey players of varying standards. Therefore talent identification Programs for female field hockey should include assessments of these physical parameters.

Kumar, S.P.\textsuperscript{83} (2007) Development of Norms for the Selection of Volleyball Players of Nagarjuna University. in this study total 13 team of different college Nagarjuna University was used. Total 127 male students of below 25 years old are taken as subject. The purpose of this study was to develop norms for selection of team. Selected test items are used for this study, 4×10mts Shuttle Run, Standing Broad Jump, Vertical Jump, 50mts Dash, Height, Weight and Volleyball Skill Test.

Viljoen, A.\textsuperscript{84} (2004) carried out a study to determine how 12 to 15 year old boys from the Northwest province (NW) compare to Australian (AUS) and South African (SA) boys of similar age with 47 regard to the Talent Search-program developed in Australia. A total of 402 boys between the ages of 12 and 15 years were tested. The

\begin{itemize}
\item \textsuperscript{83}Kumar, S.P. (2007).\textit{Development of Norms for the Selection of Volleyball Players of Nagarjuna University.} Unpublished dissertation, M.Phil.(Physical Education), university of Pune. Maharashtra.
\end{itemize}
Australian Talent Search model and norms were used for testing purposes and comparisons of children from AUS, SA (Du Randt, 2000) and from the NW. The Statistica computer processing package was used to process all data. Descriptive statistics was used to determine the means (M) and standard deviations (SD) for each age group in the NW province. Analyses of variance (ANOVA) was used to determine differences between groups (NW-SA, NW-AUS, SA-AUS) and the Bonferroni technique (Thomas and Nelson, 1996) was used to determine statistical significance (p < 0.05) of differences between groups. The Australian boys generally achieved statistically significant better values than the NW and SA boys with regard to their anthropometrical characteristics, physical and motor abilities. The motor and physical performance of boys from the NW, when compared to SA boys of the same age was generally significantly poorer although the differences were smaller. The vast majority of boys in the NW province are not exposed to physical activity or sport and come from low socio-economic (SES) conditions which might have contributed to the below average performance of the group. Due to the differences in compared results, it is recommended that the NW province should develop their own set of norms for talent identification purposes. It is further suggested that norms be compiled for each racial group as well as for the entire group when the general sport talent (TID) of boys in the NW province are analysed and that both sets of norms should be applied. D. G. Henson.  

Talent identification in most sports occurs through mass participation and the process of natural selection; track and field does not enjoy such widespread participation. This paper reports on a project undertaken for the following purposes: improve the means by which youth with the potential for high level performance can be identified; develop normative tables for scores on various tests known to be indicators of track and field performance; develop statistically based equations for predicting future performance from test scores; establish norms for males and females at various competitive levels and different events; begin developing a scientifically rigorous method of predicting potential performance as well as the event that would be most appropriate for a particular athlete; and create a database that could be used for comparisons in the future. Approximately 1,200 male and female athletes throughout the country representing a wide range of abilities were

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evaluated using a series of tests of muscular power and speed, and anthropometric measures. Based on results, norms and predictive equations were constructed for several categories including sex, event, and level of competition (i.e., high school, college). Recommendations regarding a methodology for future talent identification and 26 statistical tables are included.

**Singh, A.** (1986) conducted a normative study of physical fitness of Punjab university men students. He applied Fleishmans test battery or four thousand male students belonging to the various colleges affiliated to Punjab University to collect the data. The students ranged between 17 to 22 years of age. He found linearity of physical fitness status according to age. The students of rural areas were significantly superior in all the test items than urban students. He developed percentile norms and established their reliability, subjective and validity. 

**Singh, A.** (1986) conducted a study to develop physical fitness norms of Punjab state high school boys. He randomly selected five thousand school boys of Punjab state. The sample included rural and urban subjects in equal number for the collection of in data. He included following test items (1) standing broad jump (2) sit and reach test (3) agility run (4) sit-up bent knee (5) 50 meter dash (6) push-ups(chair) (7) cricket ball throw (8) 600-meter run walk. He observed significant difference in number of test items between urban and rural school boys. Significant difference relationship between age and performance of the subjects was also observed. The test items were standardized through the development of percentile norms which was found to be suitable to access the physical fitness of Punjab state high school boys ranging between 12 to 15 years of age.

**Kumar, D.** (1998) the main purpose of this study was to evolve physical fitness norms on various items of Fleishmans fitness battery for high and higher secondary school boys of Himachal and also Himachal Pradesh evaluate the physical fitness level of the secondary school male students of Himachal Pradesh. To accomplish the study 3,840 students between the age group of 13 to 16 years were randomly selected from both the urban and rural area. The results have shown that there was a significant difference from fifteen years to sixteen years male subjects of Himachal Pradesh in almost all fitness components. The boys of 16 years age were found significantly

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superior than 15 years to 13 year boys. The fifteen boys were better than 14 and 13 years boys. Similarly 14 years boys were superior then 13 year boys in all the 75 components of Fleishmans test battery. The result of the study have also shown that the male subjects of rural areas were significantly superior than urban subjects in six of ten fitness components of Fleishmans test battery.

Morrison, L.L. (1965) administered a twenty-items criterion battery to 120 college women at Madison college during a four-week period T-score were summed for each category of test items (body impetus giving impetus to an object, and using an implement to give impetus to an object) and for the battery of twenty items. The data were treated by means of the BIMD 34 programme. A three-item and a five-item battery were selected to predict basic sport skill ability. The validity coefficient, reliability and objectivity coefficient was calculated and norms for five groups of ability were developed for both tests. Fitness test had been constructed by North Carolina State (1961) The test items were thirty-second bent-knee sit-ups, thirty-second side stepping, standing broad jump, and thirty-second squat, thrusts for boys and girls, in addition, boys of ages twelve to seventeen performed full push-ups and all girls and boys of ages nine to eleven were designated as follows: inferior, poor, average good and excellent. Performed a modified form of pull-ups. Percentile norms were available separately for boys and girls at each age nine through seventeen years.

Levels of achievement.

The AAPHER youth fitness tests project represented the first attempt by the physical education profession to establish national norms. The test battery was originally developed in 1957 by a special Committee of the AAPHER’ Recreational Council. The youth fitness test now consists of six items for boys and girls of age groups 10 to 17 and college men and women. The norms were revised to up to date it and make more scientific after comparing the achievements of the youth of Great Britain, Japan, etc., with the American norms. The youth fitness test consists if the following:

1. Pull – ups (modified pull-ups for girls).
2. sit – ups,
3. Shuttle run,

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4. Standing broad jump,
5. 50 yards run,
6. 60 foot ball throw, and
7. 600 yards run walk.

The norms were revised to update it and make it more scientific after comparing the achievement of the youth of Great Britain, Japan etc. with the American norms.

The Canadian Association of Health, Physical Education and Recreation Youth Fitness Programmed started in 1964. The norms as developed were bearing sufficient reliability and validity. The battery consists of the following items for boys and girls age group 7 to 17.

a) One minute speed sit up,
b) Standing broad jump,
c) Shuttle run.
d) The fixed arm hang,
e) 50n yard run, and
f) 300 yard run.

An International research programmed for the standardization of physical fitness tests was undertaken by the International Council of Health, Physical Education And Recreation i.e. ICHPER Larson.90 (1967: 52). A committee on the standardization of physical fitness test ICHPER was appointed to set u standards and to construct instruments for the measurements of physical fitness in 1964 at Tokyo.

A survey was conducted and a report on the tentative standard was distributed to all members of the committee for review. The comments and recommendations received were discussed at the meeting held in Maaglingen, Switzerland in august, 1967. the performance tests items were developed in two parts. The basic combination of tests items includes endurance run (100 meters run-walk, 800 meters run- walk).50 mts sprint, pull-ups, (pull ups and the fixed arm hang), standing broad jump and grip strength.

The following additional items for application under special circumstances are also involved: 50 meters sprint (2 mins), sit-ups (25-20), repetition bench presses (15 kg

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In India, in order to arouse consciousness towards physical fitness, National Physical Efficiency Drive was launched in the country in 1959-60 by the Union Ministry of education. The scheme is to award recognition by awarding star pins and certificates to those who score in all the items of the tests battery, the prescribed minimum for any of three levels of achievement envisaged, namely one-star, two-star, three – stars. Twenty national awards are also made to those who are adjudged the top twenty in the National Physical Efficiency test or a National Award competition each year.

The “A” battery of the test consists of the following items:

1. 100 meters run,
2. 800 meters run (men and women),
3. 200 meters run (women),
4. Long Jump,
5. High jump,
6. Putting the shot.

In the “B” battery some of the athletic field items were replaced by items like Dand, Baithaks, Carrying weights, etc.

After organizing it two years on an experimental basis, the scheme has been continuously evaluated every year by organizing a seminar for state liaison officers in the National Physical Efficiency Drive. The norms have been changed a number of items as a result of the deliberation at those seminars.

However, the “A” battery consisting of purely athletic items has been more or less constant and the adhoc norms prescribed for three levels of recognition remains unchanged.

Attempts to evolve norms on scientific basis have not yet borne fruit. The NPED is intended to promote skills in track and field events well. Hence these items are in the “A” battery. However it should be noted that the testing of physical fitness should eschew skilled items such as high jump and long jump.

This is the basis of the items included in the American Association of health, Physical Education and Recreation (AAPHER) youth fitness test of USA, which is perhaps the
first National Battery adopted by any country in the world. Modification of this has
been attempted in other countries such as Canada, Japan, and West Germany.

**Singh, P.** (1988) undertook a normative study of the physical fitness of male
Teenagers of the state of Jammu and Kashmir in the ages 13 through 19 years. The
variables considered were, pull-ups (arm and shoulder girdle strength), bent knee sit-
ups (abdominal strength), shuttle run (agility), and 600 mts run walk test (cardio-
vascular endurance). He concluded that the subjects belonging to age group 16
through 19 years showed better performance in all variables over the other age group
of 13 through 15 years.

**Sreedevi, R.** (1984) constructed norms using the AAPHER fitness test for girl in
secondary schools. Her subjects were eight girl students of VII th and IXth standard
studying in Kendriya Vidyalaya, Gwalior.

**Monga, R.** (1984) constructed a Physical Fitness test battery for girls student (age:
10 to 14 years) of Delhi. Norms were established on a sample of 5000 girls belonging
to different socioeconomic groups, age range physical standards. Both T- scale and
Percentile norms were established. Validity (face validity, criterion related validity
and factorial validity) and reliability of the test revealed acceptable values. The
reports indicate that the test battery was found to be easily usable in school as per
available facilities and equipments.

**Das, T.K.** (1980) prepared norms for evaluating performances in physical fitness for
classes IXth, Xth and XIth in the Government Higher Secondary Schools of the union
territory of Delhi. Twenty percent of the schools in rural and urban areas in the same
population were taken for this study. In each school ten percent of students were
tested on the items of AAPHER youth fitness test and NPFP battery “A”. The items of
NPFP were the same as included inn the syllabus of central board of secondary
education. Norms were prepared for the boys IX,X and Xi classes and was
statistically analyzed it was concluded that a comparison of the obtained data with the
data of American .students show that the Indian student classes IX, X and XI seems to

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be very poor in abdominal strength. The performance of student of class IX in all items of youth fitness tests was poor and there was a remarkable spurt of performance in classes X and XI through still than of students in the United States of America except on pull-up measuring shoulder girdle strength.

Singh, R.M. (1986) prepared physical fitness norms for the high school boys and Punjab state. Data were collected on 5000 subjects from various schools in the state. The test that was administrated consisted on eight items, viz, standing broad jump, sit and reach test, agility run, sit-ups bent knee, 50 meter dash, push ups(chair), cricket ball throw and 600 meters run and walk. The percentile norms for physical fitness tests were found to be valid and suitable to assess the physical fitness level of the high school boys in the age group of 12 through 15 years.

Eio, I. (1988) conducted this study is to clarify the factorial structure of physical fitness of Korean and Japanese college judoists and to establish a test battery of physical fitness including to find effective instruction methods. Twenty-one morphological and fifteen fitness measures were administered to 60 Korean and Japanese judoists in May, 1985. Principal component analysis and normal varimax were applied to the correlation matrix, which was calculated with 36 test variables mentioned later. Considering degree of contribution of each factor extracted, the ability space expressed as factor was constructed with the factors showing the significant degree of contribution to total variance. The results obtained were: 1) factor analysis, six factors were obtained; physique, static strength, leg, grip, and explosive strength. 2) Japanese judoists were superior to Korean judoists in physique and static strength. 3) Korean judoists were superior Japanese judoists in leg and grip strength. 4) In spite of the above analysis, however, a great deal of overlapping was found in distribution of Korean and Japanese college judoists groups.

Harpreet (1988) formulate specific physical fitness tests keeping in view the falling standard of Indian hockey teams in international competitions. General physical fitness has been made the base of the selection of the players which is, however, unscientific because general physical fitness test do not measure the specific physical

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fitness for a particular game. The subordinate purpose was to assess the relationship of each physical fitness test to hockey performance. The subjects were 50 female hockey players of inter-University Indian combine University, state and national level. The dependent variable was hockey performance, which was evaluated by a panel of experts. The independent variable was evaluated through specific fitness tests constructed by the investigator. Suitable statistical procedure was adopted for computing the validity, reliability, and objectivity of the test battery. Analysis of the data revealed significant relationship of hockey playing ability to the test develops by the investigator. Study was done by Biswas, A. K. \(^98\) (2005) where he tested 4000 primary school children of West Bengal. He tested speed, agility and leg explosive strength. On the available raw data norms were created for the same group.

Kangane S.E. \(^99\) (2005) Development and Standardization of Test Battery for the Selection of Junior Handball Player of Maharashtra, in this study total 600 Male student are taken as a subject from Maharashtra. The purpose of this study was to develop and standardize test battery for junior Handball player of Maharashtra. Selected test items are used for this study, 12min t/w, Sit ups, Push up, Handgrip, Vertical jump, 50m dash, Sit and Rich, Height, Weight, fat%, BMI, B.P, P.P.E.R, R.R, Skill test of Handball.

Prabhu, A.D. \(^100\) (2011) the study titled To Prepare Norms of Mountaineers aged 17 to 40 Years was done on male mountaineers aged 17 to 40 years. The objective of the study was to know the physical fitness and psychological status and of mountaineers considering the prepared norms. For the study the mountaineers aged 17 years to 40 years coming for the up gradation courses at Nehru Institute of Mountaineering, Uttarkashi were chosen. A total of 270 subjects were chosen for the study. To know the physical fitness status the tests conducted were Height, Weight, Body Mass Index, Bioelectrical Impedance, Handgrip strength test (Right & Left), V-sit test, Wallsit legs strength test, Scale catch test, standing stork test and Push-up test. To know the psychological status of mountaineers the Sixteen Personality Factor test. Descriptive


100 Prabhu A.D. (2011). *To Prepare Norms of Mountaineers aged 17 to 40 Years*, Unpublished doctorate dissertation in physical education, University of Pune, Maharashtra.
analysis was done by testing the Mean, Median and Standard Deviation. Percentile method was used to prepare norms. From the analysis of physical fitness tests (selected variables) done it can be concluded that the mountaineers with increase in age the physical fitness of mountaineers is seen to deteriorate.

From the above research it is revealed that morphological factors, physical fitness and skill are important aspects for the player in the game of handball. Above reviews also show that evaluation and assessment of players for selection and training purpose is important. Above reviews indicate non availability of norms and selection criteria for senior handball players which is necessary for the progress of the game hence the study. The review has helped the researcher in giving direction for the current study “Development of norms for selection of senior male Maharashtra state handball players”. Suitable tests fulfilling the activity the handball players perform and the authentic requirements were selected and are presented in the chapter III.